The University of Chicago

AN INQUIRY INTO CERTAIN REGIONAL ASPECTS OF SHORT-RUN ECONOMIC CHANGE

A PART OF A DISSERTATION SUBMITTED TO THE FACULTY OF THE DIVISION OF THE SOCIAL SCIENCES IN CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF ECONOMICS
MARCH, 1944

By
RUTLEDGE VINING

Reprinted from
ECONOMETRICA
Vol. 13, No. 3, July, 1945
Vol. 14, No. 1, January, 1946
Vol. 14, No. 3, July, 1946

The University of Chicago

AN INQUIRY INTO CERTAIN REGIONAL ASPECTS OF SHORT-RUN ECONOMIC CHANGE

A PART OF A DISSERTATION SUBMITTED TO THE FACULTY OF THE DIVISION OF THE SOCIAL SCIENCES IN CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF ECONOMICS
MARCH, 1944

By
RUTLEDGE VINING

Reprinted from
ECONOMETRICA
Vol. 13, No. 3, July, 1945
Vol. 14, No. 1, January, 1946
Vol. 14, No. 3, July, 1946

R. UNIV.
BIBLIOTHEEK
LEIDEN

Reprinted from
ECONOMETRICA, Journal of the Econometric Society, Vol. 13, No. 3, July, 1945
The University of Chicago, Chicago 37, Illinois, U.S.A.

REGIONAL VARIATION IN CYCLICAL FLUCTUATION VIEWED AS A FREQUENCY DISTRIBUTION

By RUTLEDGE VINING

The present essay is one of a series that has come from an inquiry into the regional variation of cyclical fluctuations of business activity. The thesis is explored here that a national sum or average used to measure economic fluctuations within a nation is actually an estimate of a parameter of a frequency distribution of corresponding measurements for the component parts of the nation and that such frequency distributions have a typical shape depending upon the phase of the business cycle and the intensity of the change in process. A second essay that is planned for subsequent publication will inquire into the geographical make-up of these frequency distributions in order to study evidence of regional patterns in the cylical evolutions of business. The grounds for expecting certain patterns are worked out in terms of the nature of industrial location and regional economic specialization. A third study will develop a concept of economic region that is considered to be appropriate for business-cycle analysis, and illustrative material will be presented in which rough estimates of certain regional multipliers are attempted. In that study we shall raise certain of Professor Joseph A. Schumpeter's objections to aggregative or macrodynamic analysis, and an effort will be made to illustrate that our method, together with an appropriate conception of economic region, may supplement aggregative statistical analysis and show something of the evolutions of short-run economic change so vividly described by him.

1. TWO ASPECTS OF BUSINESS CYCLES

At least two aspects of business cycles may be singled out for statistical study. Professor Gottfried Haberler explains that he means by "depression" a state of affairs in which "real income consumed, real income produced, and the rate of employment are *falling* or are *subnormal* in the sense that there are idle resources and unused capacity," and that by "prosperity" he means the converse situation in which real income and employment are *rising* or are *high*.[1] In accordance with

[1] Gottfried Haberler, *Prosperity and Depression*, 3rd ed, rev., Geneva, League of Nations, 1941, p. 259.

these understandings, two measurable aspects of business cycles may be studied: (1) the absolute level of economic activity and (2) the direction and rate of change of economic activity.

If for the purpose at hand prosperity and depression are viewed in absolute terms as differences in levels of activity, the measures might

TABLE 1

PERCENTAGE CHANGES OF NATIONAL INCOME PAYMENTS, 1929–42

Year	Income Payments[a] (Millions)	Income of Given Year as Percentage of Preceding Year	Percentage Gain or Loss
1929	82,538	...	...
1930	73,303	88.81	−11.19
1931	61,966	84.53	−15.47
1932	47,367	76.44	−23.56
1933	46,235	97.61	− 2.39
1934	52,865	114.34	+14.34
1935	58,493	110.65	+10.65
1936	67,957	116.18	+16.18
1937	72,275	106.35	+ 6.35
1938	66,117	91.48	− 8.52
1939	70,747	107.00	+ 7.00
1940	76,220	107.96[b]	+ 7.96
1941	91,910	120.59	+20.59
1942	114,039	124.08	+24.08

[a] Data for 1929 through 1939 from *Survey of Current Business*, Vol. 22, July, 1942, p. 23; for 1940 through 1942, *ibid.*, Vol. 23, June, 1943, p. 21. These figures are the summations of the Department of Commerce estimates of state income payments.

[b] Percentage change over estimate for 1939 as given in the June, 1943, reference.

consist (1) of some reduction of relatives on a fixed base of employment, production, or income, or (2) of the percentage of employables that are employed. If, on the other hand, prosperity and depression are viewed in terms of direction and rate of change, then the criterion by which the business cycle is measured might consist of the rate of change of income, production, and employment measured as the percentage change between successive periods. For our purpose of studying regional differences in the response to cyclical forces in process in the nation, it seems that this latter criterion would be more appropriate. When the level of business activity is the variable studied, more prominent is the difficulty of differentiating between the respective effects of

secular and cyclical forces, and more serious is the lack of independence between successive observations of the variate. Two regions may be currently showing closely similar responses and equal *rates of change*, and yet the levels of activity as measured by percentage unemployed, or by a more hazardous percentage of trend, may be quite different because of different responses in past periods. Thus, we shall concentrate our attention in this study upon the behavior of rates of change of income, estimates of which we shall derive from annual series of income payments. These latter, except for infrequent circumstances

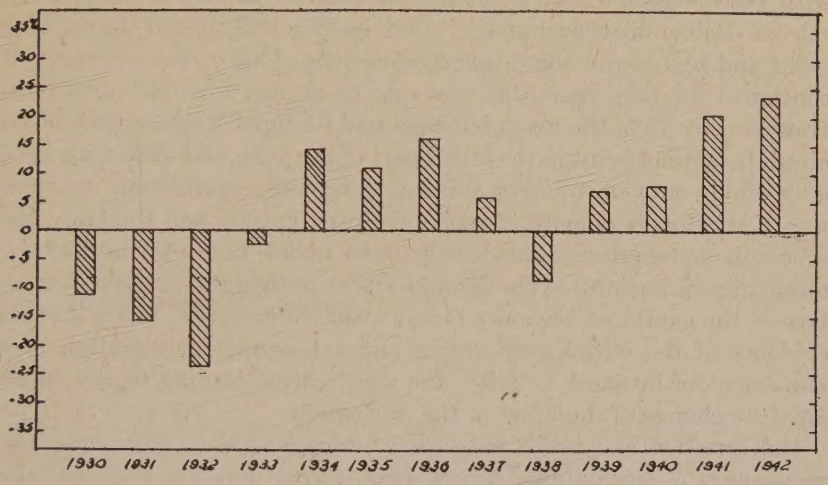


FIGURE 1.—Percentage change in national income relative to preceding year.

and for well-known differences with respect to amplitude of fluctuations, are highly correlated with real income, production, and employment.

2. CYCLICAL BEHAVIOR OF NATIONAL INCOME

Let us first briefly review the cyclical behavior of income as exemplified by the movements of the national series of income payments. Table 1 and Figure 1 show for the United States the annual percentage changes of income payments over something more than the decade of the 1930's. Money income in the nation as a whole is seen in these annual data to have diminished at an increasing rate at least until some time in 1932. Either in 1932 or 1933 the turning point of the rate of change took place. The annual data show that the turning point of the absolute volume of income payments took place either in 1933 or in 1934. Monthly data indicate that these turning points occurred in 1932 and 1933 respectively. Needless to say, a movement in the rate of

change or in the absolute volume of income is not necessarily a sustained movement over any definite period. It may be noticed in passing, however, that the behavior of income and its rate of change over these fourteen years are approximately in accord with theoretical expectations. We should expect, on the basis of reasoning associated with the analysis of the "Wicksellian cumulative movement," that once a movement is initiated it should continue in the same direction cumulatively picking up momentum at first but gradually spending itself until a turning point is reached.[2] Figure 1 shows that beginning with 1930 income fell at an increasing rate for three years. Then the rate of decline decreased and by 1934 income had passed the turning point and had begun the upward movement. This upward movement continued for four years, but the rate of change was not consistent. However, by 1937 the rate of change had declined to the extent of an absolute turning point in the latter part of the year, and 1938 witnessed a declining movement. For numerous reasons—world-wide rearmament, world-wide policies of economic intervention, and the like—the economic system during the decade under review has not exhibited the mechanics of business-cycle dynamics that is thought to have characterized the capitalist economy before 1930. Nonetheless, there is some evidence of the initial acceleration and subsequent deceleration of a movement of business activity, the deceleration leading finally to an absolute change of direction of the movement.

Our question now arises as to what interpretation to place upon the movements of this national figure. It obviously does not represent the business cycle for any particular part of the nation. Rates of change and turning points derived from series giving income in any of the specific areas within the nation might deviate considerably from rates of change and turning points shown by the summation figure for the nation as a whole. What, then, is the relationship between the movements of the national income series and the movements of the income series for the component areas within the nation?

3. AN INTERPRETATION OF THE NATIONAL RATE OF CHANGE

It may be pointed out immediately that the rate of change of the national-income series is the weighted mean of the rates in the different regions, the weights being proportional to the respective incomes of the regions. The rate of change for the nation as a whole we may denote by $\Delta Y/Y$ where Y is the national income for a given period and ΔY is the difference between Y and the income of the following period. The rate of change for the jth region we may denote by $\Delta Y_j/Y_j$. Then

[2] *Ibid.*, pp. 283–287, 323–326, and chap. xi.

$$\frac{1}{\sum_1^n Y_j} \sum_1^n \frac{\Delta Y_j}{Y_j} Y_j = \frac{\Delta Y}{Y},$$

for the summations are identical with the national figures. Under certain conditions this weighted mean is equal to the unweighted mean of the rates of change by regions. These conditions may be conveniently set forth as follows:

Let the unweighted mean be represented by

$$K = \frac{1}{n} \sum_1^n \frac{\Delta Y_j}{Y_j}$$

and let the weighted mean be represented by

$$K' = \frac{1}{\sum_1^n Y_j} \sum_1^n \frac{\Delta Y_j}{Y_j} Y_j = \frac{\Delta Y}{Y}.$$

Then, it may be shown that[3]

$$K' = K + r\sigma_{\Delta Y_j/Y_j} \frac{\sigma_{Y_j}}{M_j},$$

where σ_{Y_j} and M_j are respectively the standard deviation and the mean of the regional incomes, where $\sigma_{\Delta Y_j/Y_j}$ is the standard deviation of the regional rates of change, and where r is the coefficient of correlation between the rates of change and the income in the different regions.

That is to say, if there is no correlation between the regional rate of change of income and "economic size" of the region the unweighted mean of the regional rates of change will equal the national rate of change. If the correlation is positive the national rate should be greater than the mean of the regional rates—and conversely. Now the mean is a parameter of a frequency distribution, and following this line of rea-

[3] G. U. Yule and M. G. Kendall, *An Introduction to the Theory of Statistics*, 11th ed., London, Charles Griffin and Company, Limited, 1937, p. 303. Let $X_j = \Delta Y_j/Y_j$ and let Y_j = Income of Region j and denote deviations of X_j and Y_j from the respective means by x and y. Then

$$\frac{\sum xy}{n\sigma_x\sigma_y} = r,$$

$$\sum XY - nM_X M_Y = nr\sigma_X\sigma_Y,$$

$$\frac{\sum XY}{\sum Y} = K' = \frac{nM_X M_Y}{\sum Y} + \frac{nr\sigma_X\sigma_Y}{\sum Y}$$

$$K' = K + \sigma_{X_j} \frac{\sigma_{Y_j}}{M_Y}.$$

soning we may interpret the national series of percentage changes as a series of averages, each of which is a measure of central tendency of a frequency distribution of the respective percentage changes of the component parts of the national area. This interpretation is valid provided the correlation referred to above is in fact small. The question then arises regarding the shapes of these frequency distributions.

The most obvious hypothesis, as a first approximation, that occurs to one in rationalizing expectations with respect to these shapes is some version of the normal hypothesis. The ground here, based upon the classical theory of errors of observation, is notoriously shaky and uncertain when used as support for a theory involving the behavior of our type of data. Yet, courage is given to those who would use probability concepts in economic analysis by a statement from one who has attained a reputation as an authority on such matters. Trygve Haavelmo looks upon probability concepts as parts of the essential apparatus of economic analysis without which relations between theoretical hypotheses and objective observations become meaningless. Students of the business cycle will recall Mr. Keynes' caustic review of Tinbergen's efforts to test business-cycle theories statistically.[4] The present writer must say that such points as raised by Keynes, points that are not novel in statistical theory, have seemed to him to weaken impressively most econometric constructions. But Mr. Haavelmo is a man whose judgment is respected and who can be depended upon to have considered all the various aspects that might occur to one who is in no sense a specialist in the field. Haavelmo states his position as follows:

> The present writer finds it impossible to share this view [that the introduction of probability terms does violence to the nature of economic facts]. Quite the contrary, I should like to make the following claims: first, that there can be no harm in considering economic variables as stochastical [random] variables having certain distribution properties; second, that only through the introduction of such notions are we able to formulate hypotheses that have a meaning in relation to facts; and third, that these notions are precisely the tools needed for an objective and intelligent discussion of such questions as those of Lord Keynes quoted above.[5]

So, in view of this judgment, it may be justifiable to take the space to suggest as a first approximation a hypothesis regarding the expected shapes of frequency distributions of rates of business change within the component regions of the national area. A refined formulation of a

[4] J. M. Keynes, "The Statistical Testing of Business Cycle Theories," *Economic Journal*, Vol. 49, September, 1939, pp. 558–568; also, the reply by Tinbergen and the comment by Keynes, *ibid.*, Vol. 50, March, 1940, pp. 141–156.

[5] "Statistical Testing of Business Cycle Theories," *Review of Economic Statistics*, Vol. 25, February, 1943, pp. 13–18, esp. pp. 13–14.

theory of business-cycle frequency distributions that will account for characteristic evolutions in the shapes of these distributions as the different phases of the business cycle unfold will wait upon the work of mathematicians.

4. THEORETICAL FREQUENCY DISTRIBUTIONS: A TENTATIVE HYPOTHESIS

In order to illustrate how a certain specification of conditions implies a frequency distribution of a certain shape, we may paraphrase a discussion in R. Gibrat's study, *Les inégalités économiques*.[6] In the following illustration the method that is used is Gibrat's; the application and the examples are our own. Let us begin by assuming very simple, and therefore grossly unrealistic, conditions. Let us say that we have divided the national area into its many component regions. We shall postpone until a later date a discussion of the essential attributes of an economic region that we should regard as defined appropriately for business-cycle analysis. At this point let us simply say that we have so designated these regions. Suppose that for each of these regions we have a series of income payments, which we reduce to a series of relatives with our origin period as the base. Thus, for our first unit of time, the income-payment relatives of all the regions are 100. Now, let us assume that for one cause or another there is a tendency for the national-income relative to rise by 1 per cent per time unit so that the average absolute change in these regional-income relatives is 1 per cent per time unit, assuming an independence between the size of the region and the magnitude of the income relative. And to be explicit we reiterate that this is not an average rate of change of 1 per cent but an average absolute rise of these relatives of 1 per cent. That is, at the end of one time unit the average income relative, or the national-income relative, will have risen to 101. However, this rise is not uniform over all the regions. In some regions the entrepreneurs are more aggressive or fortunate and obtain a relatively large share of the increased money demand. In some regions labor difficulties or unfavorable weather conditions impede a rise in employment and income. In some regions bottlenecks temporarily appear, while in others bottlenecks previously acting as a deterrent to an employment rise are broken. We shall sup-

[6] Librairie du Recueil Sirey, Paris, 1931. This book illustrates the very broad application of certain types of distributions to economic data. The chapters pertinent for the present discussion are: chap. iv, "L'ajustment par les formules du calcul des probabilités"; chap. v, "La formule de l'effet proportionnel"; and chap. vi, "La loi de l'effet proportionnel." Also, it will be noticed that in our later illustrations we adopt the method and much of the notation used by Professor Jacob Marschak in his study, "Income Inequality and Demand Studies: A Note," Econometrica, Vol. 11, April, 1943, pp. 163–166.

pose that, for one cause or another, half the regions are favored in the first time unit and show income rises that are larger by s than the average and that the other half are disfavored and show income rises that fall short of the average by s. Thus at the end of time unit 1, the income relatives in half the regions equal $101 + s$ and in the other half, $101 - s$. By the end of time unit 2, this rising tendency being maintained, the average is increased to 102, but again half the regions are favored and half are disfavored. Here we shall make a fundamental assumption. We shall assume that this general tendency and this complex of causes that differentiates the regions into those relatively favored and those relatively disfavored act no differently upon the regions previously favored than upon the regions previously disfavored. That is to say, we assume that causes operating in one time unit are independent of causes operating in other time units so that the change in a region's income relative in the second time unit is independent of the change taking place in the first time unit. Consequently, we should expect four groups of regions at the end of the second time unit:

1. Those relatively favored two times, whose income relative at the end of the 2nd time unit is $102 + 2s$;
2. Those relatively favored, then relatively disfavored, whose income relative at the end of the 2nd time unit is 102;
3. Those relatively disfavored, then relatively favored, whose income relative at the end of the 2nd time unit is 102;
4. Those relatively disfavored two times, and whose income relative at the end of the second time unit is $102 - 2s$.

We patently have here a development of the binomial distribution. It is as though the regions to be relatively favored in a given unit of time are determined by chance drawings from an urn. If there are N regions and if the chances of being favored and of being disfavored are denoted by p and q respectively, then we should expect at the end of one time unit Np regions with an income relative of $101 + s$ and Nq regions with an income relative $101 - s$. At the end of the second time unit, by virtue of the independence of causes or events, we should expect that among the Np relatively favored regions there will be $(Np)p$ or Np^2 regions that will again be favored. Likewise, Npq regions will have been favored once and disfavored once, Nqp regions will have been disfavored and then favored, and Nq^2 regions will have been relatively disfavored in both time units. By the end of the third time unit, we should expect that among the Np^2 twice favored regions, $(Np^2)p$ or Np^3 regions would have been favored for the third time. That is, we should expect the following development by time units:

At the End of Time Unit	Mean Income Relative		Distribution of Regions by Income Relative (F = Frequency; Y = Income Relative)			
0	100	F	N			
		Y	100			
1	101	F	Np		Nq	
		Y	$101 + s$		$101 - s$	
2	102	F	Np^2	$2Npq$	Nq^2	
		Y	$102 + 2s$	102	$102 - 2s$	
3	103	F	Np^3	$3Np^2q$	$3Npq^2$	Nq^3
		Y	$103 + 3s$	$103 + s$	$103 - s$	$103 - 3s$
. . . . .						
n	$100 + n$	F	Np^n	$nNp^{n-1}q$	$\frac{n(n-1)}{2} Np^{n-2}q^2 \cdots$	
		Y	$100+n+ns$	$100+n+(n-2)s$	$100+n+(n-4)s \cdots$	

Thus, the binomial distribution would describe the frequency distribution of these regions classified according to income expressed as relatives of a common base. Should we subtract $100 + n$ from each of the income classes we would have a distribution of the regions according to the absolute change of the income relative—that is, according to the percentage change of income from the base period—and obviously this operation would not change the shape of the distribution. But this percentage change from the base period is equivalent to the percentage change taking place within any time period, say, within a year.

In this illustration we assumed that the chances of a region's being favored within a given period was the same as its chances of being disfavored. Consequently, the distribution would rapidly approach Laplaces's Law as n is allowed to become larger. But if we should assume that the chances of any region's being relatively favored in an economic expansion is greater than of being disfavored then the distribution would be skewed positively until larger values of n are reached. If this chance of being favored were a direct function of the rapidity of the change of the national sum, we should expect a more marked skew of the regional percentage changes for periods of strong change than for periods of mild change. Corresponding expectations would hold, of course, for periods of decline as for the periods of increase. If we should assume that the chance of a region's being relatively favored is some function, not of the rate of change of the national sum, but of the rate at which this rate of change is changing, then our expectation would be

for evidences of a positive skew so long as the relative income rise was gaining momentum and for the appearance of a negative skew as the rate of rise begins to decline just prior to the turning point of income payments.

Our development so far has led to an expectation of an approximately normal distribution of the changes by regions of income relatives, the approximation being the closer (1) the more nearly equal are the chances of being relatively favored and of being relatively disfavored within a given time unit, and (2) the longer the time over which the total changes are measured. By virtue of our dealing with income relatives, the units in which these income changes are measured are peculiar. They are not common units such, for example, as dollars. The unit in the case of each region is the number of dollars of income produced or received in the base period. That is, our distribution is not of ΔY or $Y_t - Y_0$, the amount of income received within the respective regions since the base period. Rather, it is of $(Y_t - Y_0)/Y_0$, the percentage change of income registered in the various regions within a given period of time, our assumptions implying that the causes operating upon regional incomes produce a proportionate effect rather than an absolute effect.

The above illustration is clearly quite artificial and unrealistic, and is, as a matter of fact, more unrealistic than is necessary in order to derive essentially the same expectations. We have assumed above that all favorably or unfavorably affected regions are affected in the same degree, and that the relative variation of each region for each time unit differs from the average variation by the same amount s. These simplifying assumptions may be dispensed with if three conditions can be satisfied. In the theory of error it is demonstrated that:

1. If the deviation of a given variate from the mean of all the variates is due to a very large number of causes, and
2. If each of these causes account for only a small part of the total deviation, and
3. If these elementary causes or factors are themselves independent in the sense that the effect of one cause is independent of the effects of prior causes,

then the distribution of the variates will conform to Laplace's Law.[7] Let us denote by K the mean value of the regional percentage changes

[7] A variety of proofs of this theorem are available. Cf., e.g., J. V. Uspensky, *Introduction to Mathematical Probability*, New York: McGraw-Hill Book Company, 1937, pp. 283–297, and Harald Cramer, *Random Variables and Probability Distributions*, Cambridge Tracts in Mathematics and Mathematical Physics, No. 36, 1937, pp. 49–68.

in income within a given period, by X_j the percentage change in income in the jth region, and by ϵ_j the deviation of X_j from the mean. Then we have as n observations of regional rates of change

$$X_1 = K + \epsilon_1,$$
$$X_2 = K + \epsilon_2,$$
$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot$$
$$X_n = K + \epsilon_n.$$

If the above three conditions are satisfied, the ϵ's, and therefore the X's, will be normally distributed.

The satisfaction of the first condition does not appear to be beyond plausibility. Without at this time taking the space to develop the thesis, systematically, we feel that not much controversy would be aroused by treating the relevant causes determining the rate of change of a given region's income primarily in terms of industrial location or specialization and the institutional factors influencing the region's commercial ties. These characteristics would determine such magnitudes as:

i. The proportion of consumption within the region that is "imported" from without and the variation of this proportion with changes in income.

ii. The proportion of the total investment expenditures originating within the region that is expended upon "imported" investment goods, and the response of this proportion to changes in consumption.

iii. The response of investment-goods "exports" to a given change in the national rate of investment.

iv. The response of consumption-goods "exports" to a given change of national consumption.

With the use of concepts developed in recent discussions of the foreign-trade multiplier,[8] the following generalizations may be established:

1. The greater the economic specialization of a region, the greater will be the proportion of consumption that is "imported," the more dependent will be the income of the region upon "external" demand, and the less will be the effect upon income of local investment expenditures.

2. The less the short-run income elasticities of demand for the goods and services normally included among "imports," the greater will be the rates of change observable in the income of the region, and the greater will be the amplitude of fluctuation of the region's income.

3. The greater the short-run income elasticities of demand for the goods and services normally included among "exports," the greater will

[8] Haberler, *op. cit.*, pp. 461–473, and references there cited.

be the rates of change observable in the income payments within the region, and the greater will be the amplitude of fluctuation of the region's income.

These considerations suggest that all of the following factors will have a bearing upon the way in which the income of a given region will react to a sequence of events taking place within a nation: the income elasticities of the region's "export" products and "import" products; the proportion of local consumption and investment that is imported; the magnitude of the region's propensity to consume; the economic distance of the region from another region initially affected by some random impact; the maturity of the economic organization, the extent of unionization, the degree of monopolization of business enterprise, and the convertibility of resources from one use to another. At a later date we shall attempt to illustrate with arithmetic model sequences how such factors may underlie regional differences in sensitivity to cyclical forces, but without such illustrations it is clear that such characteristics could be combined in a very great number of ways. In a sense, a region's economic characteristics have been inherited from the past just as certain physical characteristics of individuals have been inherited from the past. Causes that have been operating over generations have influenced a given region's economic structure, resource supply, commercial ties, communication and transportation facilities, industrial specialization, and psychological responsiveness of inhabitants, so that the existing economic characteristics determining the cycle sensitivity of any region must be the outgrowth of a multitude of different causes. We should perhaps note here that we may speak of "random" causes, whose influences have been distributed over a lengthy past, as being responsible for a particular complex of these characteristics that determines the reaction of a region's income and still consider the "systematic" causes, as we shall at a later time, determining the position of a given region within the frequency distribution. In doing so we really are dealing with two different levels of "causes": We first consider "random" causes operating over many time periods and determining certain features of economic structure, and then, having accepted these features as they may be observed, we consider them as "systematic" factors or causes with reference to which the position of a given region within the array of all the regions may be explained. These two classes of "causes" have an analogy in an illustration of a normally distributed variate given by Whittaker and Robinson. We are asked by these authors to fix our attention upon the chest measure of an individual soldier and to reflect upon the great number of different factors that have contributed to make this chest measure what it is:

For, owing to heredity, it will have been influenced by the chest measures of his father and mother; but the chest measure of his father will in turn have been influenced by those of *his* father and mother, and so on, so that ultimately the chest measure of the individual soldier we are considering may be regarded as influenced by the chest measures of a very large number of individuals of a remote generation, each of them singly making only a very small contribution to the total effect.[9]

These are influences that are responsible for a currently observed organism that will react in a characteristic way. In addition to such influences, there are others that are currently operating, "for example, his nourishment and exercise at different ages of his life." The totality of causes includes both types, and the "*deviation of the actual chest measure of an individual from the average may be regarded as the sum of a very great number of very small deviations (positive or negative) due to the separate factors in the heredity and environment of the individual.*"[10] But, presumably, the currently existing "organisms" could be classified in accordance with the inheritable characteristics, and the response of like "organisms" to a given environmental situation could be studied. Likewise, we may perhaps consider the cycle sensitivity of a given region as the outgrowth of a large number of influences, and at the same time regard an observed cyclical reaction of the income of the region as the combined result of this cycle sensitivity together with the environmental situation.

The second condition is perhaps not so easily rationalized, for while an observed regional economic structure may be the result of a cumulation of many small events distributed over the past, certain single events or causes may produce large results. Floods, winds, drouths, and other natural events, as well as wars, strikes, subsidies, and other sharp institutional developments, may produce extreme deviations. If it were true that such causes producing large effects are in operation, then the condition must be satisfied that these "large" effects are normally distributed; else, we must expect a skew when such events occur.

The third condition is perhaps even more questionable. The fact that a region has received an impact from some cause tending in the direction of an expansion would seem to condition the expectations of the inhabitants so that now the impact of a similar cause would result in a greater effect. That is to say, the rate of change within a given time period t is not independent of the effects of causes operating in time period $t-1$. This sort of conception is the substance of the notion of the "cumulative movement."

[9] E. T. Whitaker and G. Robinson, *The Calculus of Observations*, 2d ed., London: Blackie and Son, 1937, p. 167.

[10] *Ibid.*

In order to develop a working hypothesis, let us follow the procedure of our first illustration and set down the implications of certain assumptions. First, let us assume all three conditions to be satisfied. We shall denote by X_t the income relative Y_t/Y_0 for a given region, by F_t some function of time, and by ϵ_t a normally distributed variate with zero mean. Then, we should have[11] $dX_t/dt = F_t + \epsilon_t$. Thus, this hypothesis would mean that the differences for the various regions of the income relative at time t and time zero are normally distributed[12] about the mean $\int_0^t F_z dz$, the latter being the change taking place since zero time in the mean of the regional-income relatives and equal to $K_t - K_0$. Again, this does not mean that the absolute change in dollars of income is normally distributed. It means that the percentage change of income $(Y_t - Y_0)/Y_0$ within a period of time $t-0$ is thus distributed, and as the time period is shortened this expression approaches dY/Ydt or $d \log Y/dt$. That is to say, if the three conditions were satisfied with respect to the percentage relatives, we should expect a normal distribution of the percentage rate of change of income payments or a logarithmic normal distribution of the absolute change of income. These three conditions would mean that many causes have been responsible for the particular economic structure of any given region to which the observed relative cyclical reaction of that region might be attributed, that only small effects are produced by any given cause, that the relative change of a region's income in any given time period is independent of the relative change taking place in any prior period.

Now, let us relax somewhat the last condition. This condition violates the principle of the cumulative movement. In our illustration leading to the binomial distribution we suggested, without inquiring further into the problem, that that hypothesis might have included a dependency between the current rate of change and the rate of change of the preceding period such that the chances of being favorably affected were greater when the "general" rate of change was increasing than when it was decreasing. Let us formulate a similar condition for the present consideration. We shall denote by R_t the percentage change in income in a given region within time period t so that $R_t = (Y_t - Y_{t-1})/Y_{t-1}$. Now, let us assume that this percentage change in time t is not independent of the percentage change of income in

[11] This method is identical with that used by Professor Marschak in his discussion of personal-income distribution, *op. cit.*

[12] For $X_t - X_0$ is the definite integral of the above differential expression, and if the errors in any number of independent quantities, F_1, F_2, F_3, $\cdots$, are normally distributed, the errors in the sum $F_1 + F_2 + F_3 \cdots$ will obey the normal law. See, e.g., Hugh H. Wolfenden, *The Fundamental Principle of Mathematical Statistics*, Toronto: The Macmillan Company of Canada, Limited, 1942, p. 24.

prior periods but that a given expansionary cause will have a greater relative effect if prior causes are such that the percentage rises from period to period are increasing than if prior causes have given a situation in which these percentage changes are constant or declining. We wish by our present hypothesis to express not an independence of absolute effects registered by this R_t series (which has already been reduced to the form of relative changes) but an independence of proportional effects—identical elementary causes producing identical proportional effects upon the relative change per period of time. Thus, a complex of causes that would raise a per-period relative change of 1 per cent to 2 per cent would raise a per-period relative change of 3 per cent to 6 per cent or would reduce a per-period relative decline of 4 per cent to a relative decline of 2 per cent. In positing this condition we attempt to express a circumstance in which the cumulative movement is implicit—the greater the relative change that is taking place the more volatile the expectations that motivate the decisions leading to further change, and the greater will be the tendency for further change in the same direction. Suppose then we assume that the complex of causes in operation in the national area produce systematic effects upon the regional relative changes in income, that the mean of these regional relative changes is some function of time, that the relative changes of the various regions are not affected uniformly but show instead deviations from this mean behavior. Let us assume that these deviations may be attributable to the peculiarities of economic structure together with random events that are the results of a cumulation of many elementary causes, no one of which is responsible for a large effect, and which are independent in the sense that the relative effect of one elementary cause is independent of the relative effect of prior causes (the latter condition implying a lack of independence with respect to the absolute effects upon the relative change of income). Our hypothesis, then, by virtue of a line of reasoning similar to that followed in the preceding case, implies a similar differential equation and a logarithmic normal distribution of R_t, the relative change of income by regions. Thus, the incorporation of the principle of the cumulative movement leads to the expectation of a skewed distribution of the relative changes in income, the skew being in the direction of the change in the relative change itself. That is, so long as income is decreasing at an increasing rate (for example, as was the case from 1929 through 1932) we should expect the distribution of income by regions expressed as percentages of the preceding period to have a negative skew. As the rate at which income is declining itself begins to decline, the skew of these link-relatives should become positive. This positive skew should prevail throughout the phase during which the rate of decline is dimin-

TABLE 2

FREQUENCY DISTRIBUTIONS OF ANNUAL INCOME PAYMENTS BY STATES EXPRESSED AS PERCENTAGE GAINS OR LOSSES RELATIVE TO INCOME PAYMENTS OF YEAR PRECEDING

Mid-point of Range	% Gain or Loss	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942
166	66	—	—	—	—	—	—	—	—	—	—	—	—	1
163	63	—	—	—	—	—	—	—	—	—	—	—	—	0
160	60	—	—	—	—	—	—	—	—	—	—	—	—	0
157	57	—	—	—	—	—	—	—	—	—	—	—	—	1
154	54	—	—	—	—	—	—	—	—	—	—	—	—	0
151	51	—	—	—	—	—	—	—	—	—	—	—	—	1
148	48	—	—	—	—	—	—	—	—	—	—	—	—	4
145	45	—	—	—	—	—	2	—	—	—	—	—	—	1
142	42	—	—	—	—	—	0	—	—	—	—	—	—	3
139	39	—	—	—	—	—	0	—	—	—	—	—	2	1
136	36	—	—	—	—	1	0	—	—	—	—	—	0	2
133	33	—	—	—	—	1	0	—	—	—	—	—	2	3
130	30	—	—	—	—	4	0	—	—	—	—	—	4	6
127	27	—	—	—	—	1	0	—	—	—	—	—	5	9
124	24	—	—	—	—	5	1	4	—	—	—	—	9	2
121	21	—	—	—	—	6	0	10	—	—	—	1	8	6
118	18	—	—	—	—	6	4	11	—	—	1	0	10	4
115	15	—	—	—	1	6	8	11	2	—	1	0	9	3
112	12	—	—	—	2	11	12	8	4	—	2	11	1	1
109	9	—	—	—	2	4	15	3	9	—	13	15	—	1
106	6	—	—	—	4	1	7	2	16	—	26	16	—	—
103	3	—	—	—	8	0	—	—	15	—	5	6	—	—
100	0	2	—	—	11	2	—	—	2	3	1	—	—	—
97	− 3	2	1	—	14	0	—	—	1	6	—	—	—	—
94	− 6	9	0	—	4	1	—	—	—	13	—	—	—	—
91	− 9	9	5	—	3	—	—	—	—	17	—	—	—	—
88	−12	4	8	2	—	—	—	—	—	8	—	—	—	—
85	−15	11	14	1	—	—	—	—	—	1	—	—	—	—
82	−18	8	14	6	—	—	—	—	—	1	—	—	—	—
79	−21	1	3	10	—	—	—	—	—	—	—	—	—	—
76	−24	1	3	17	—	—	—	—	—	—	—	—	—	—
73	−27	0	0	9	—	—	—	—	—	—	—	—	—	—
70	−30	2	0	0	—	—	—	—	—	—	—	—	—	—
67	−33	—	1	2	—	—	—	—	—	—	—	—	—	—
64	−36	—	—	0	—	—	—	—	—	—	—	—	—	—
61	−39	—	—	2	—	—	—	—	—	—	—	—	—	—
Mean		87.7%	84.2%	76.6%	100.2%	117.1%	111.7%*	116.4%	106.1%	92.4%	107.1%	108.2%	122.1%	130.2%
σ_m		0.96	0.70	0.75	0.77	1.24	0.54	0.65	0.53	0.53	0.44	0.47	0.91	1.75
Median		88.8	84.1	77.2	99.3	115.1	110.9	116.8	106.0	92.3	107.1	107.6	121.4	128.3
Weighted Mean		88.8	84.5	76.4	97.6	114.3	110.7	116.2	106.4	91.5	107.0	108.0	129.6	124.1
σ		6.71	4.89	5.26	5.39	8.70	3.75*	4.55	3.71	3.72	3.10	3.28	6.35	12.28
g_1		−0.612	−0.685	−0.779	+0.574	−0.105	+1.027*	−0.423	+0.120	+0.107	+0.941	+1.140	+0.991	+0.813
σ_{g_1}		0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339

* The 2 extreme states are omitted in these computations.

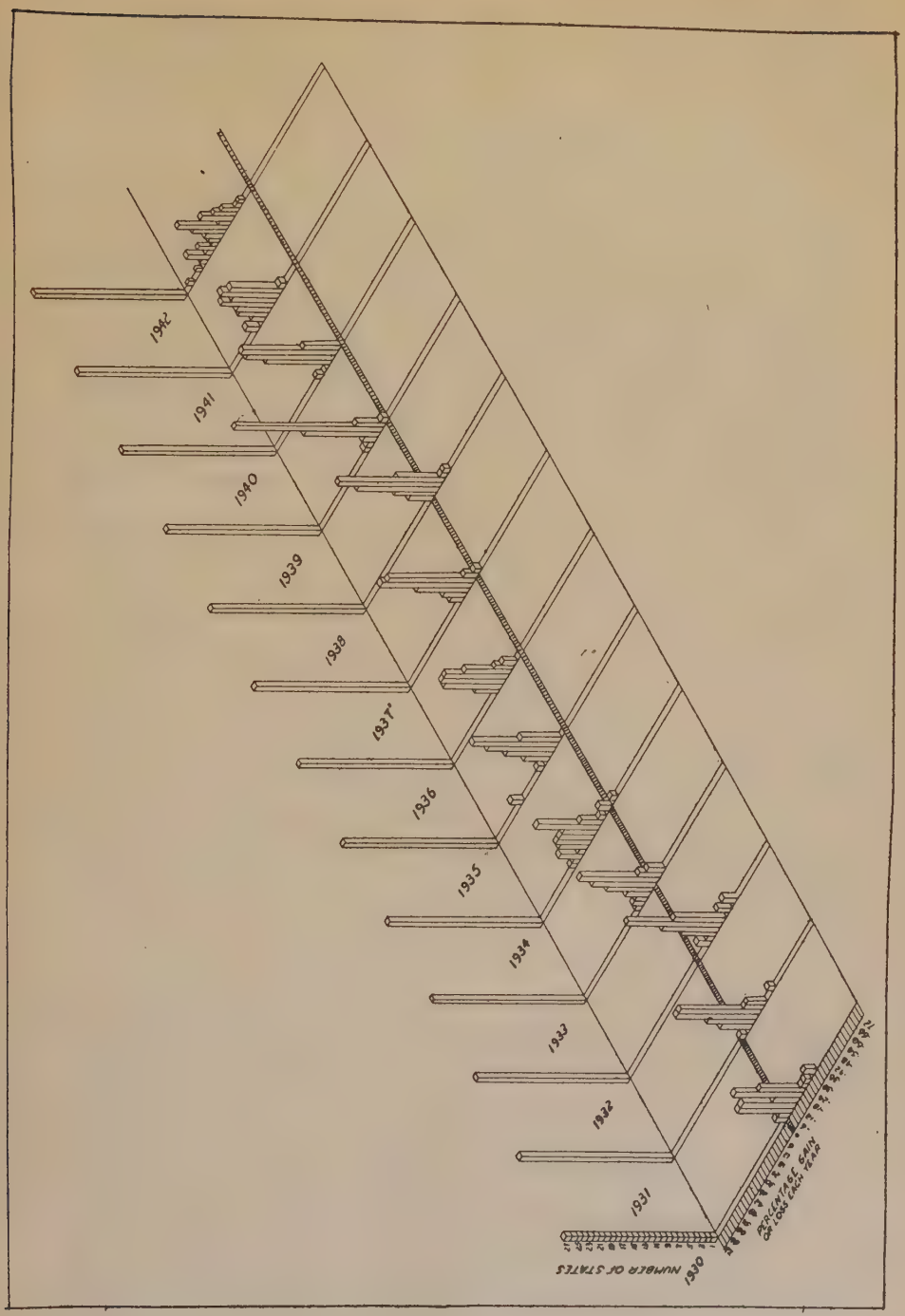


FIGURE 2.—Frequency distributions of annual income payments by states expressed as percentage gains or losses relative to income payments in year preceding.

ishing and should continue, as the diminishing rate of decline merges into an increasing rate of increase, throughout the period of this expanding rate of increase. As the rate of increase begins to decline, the skew of the link-relatives should again become negative, continuing so through the period of the increasing rate of decline.[13]

It is this last hypothesis that we shall keep in mind as we inquire into the behavior of certain statistical data. We wish to make it clear that we are aware of the awkwardness of these specified conditions, and we have indicated previously that the theory of business-cycle frequency distributions that will adequately account for the apparent systematic alteration of the shapes of these distributions, as the economy passes from phase to phase of the cycle, must wait upon a mathematician's interest. Our specifications have led to the expectation of a certain type of skew, but of course we have made use of only one type of probability function in our analysis. It may be that such a skew could be accounted for, more reasonably perhaps, on the basis of an

[13] This formulation of the expected direction of the skew has been arrived at primarily by way of intuition. The present writer does not feel competent to trace out the mathematical implications of the assumptions. Yet, certain suggestions along this line may be made. As stated, our assumptions imply a random differential equation

$$\frac{dR_t}{R_t dt} = f_t + \epsilon_t$$

with f_t some function of time, ϵ_t a normally distributed variate with zero mean, and

$$R_t = \frac{Y_t - Y_{t-1}}{Y_{t-1}}.$$

It will be noticed that by substitution the left-hand side of the equation may be written

$$\frac{\dfrac{d \log Y_t}{dt} - \dfrac{d \log Y_{t-1}}{dt}}{1 - \dfrac{Y_{t-1}}{Y_t}}.$$

When the *relative change* of income is increasing, the numerator is positive; and when this *relative change* is decreasing, the numerator is negative. When *income* is increasing, the denominator is positive; and when *income* is decreasing, the denominator is negative. Thus, when the relative change is increasing at a time when income is declining, our assumptions seem to indicate a normal distribution of negative logarithms—that is, a positively skewed distribution of the reciprocals of the antilogarithms and a negatively skewed distribution of the antilogs themselves. Likewise, when the relative change is increasing during an income rise, a normal distribution of positive logarithms is indicated. When the relative change is decreasing during an income rise we again have an indicated normal distribution of negative logarithms; and when this relative change is decreasing during an income decline, this normal distribution is of positive logarithms.

analysis leading to any one of a number of types of skew distributions.[14] As a matter of fact, however, the data are in fair conformance with the theory developed above, and we shall turn now to this statistical material. To sum up, we may state the following tentative hypothesis regarding the statistical interpretation of the rate of change of total national income:

i. That the national series of percentage changes of income may be regarded as a series of averages, each of which is a measure of central tendency of a frequency distribution of the respective percentage changes of income within each component part of the national area.

ii. That these frequency distributions are logarithmically normal.

iii. That the skews of these distributions are determined by the relationship between the sign of the change of income and the sign of the change in the rate at which income is changing; that when these signs are the same, the skew is positive, and when they are opposites, the skew is negative.

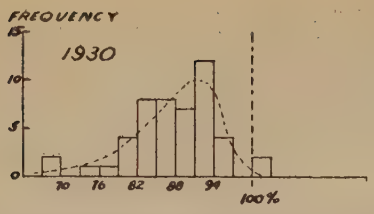
Let us now inquire into the extent to which available data support this formulation.

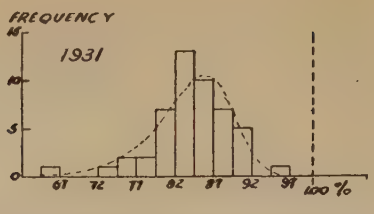
5. A STATISTICAL ANALYSIS TESTING THE HYPOTHESIS

Table 2 and Figure 2 show a series of frequency distributions computed from data on annual income payments for individual States and the District of Columbia.[15] Income payments for each year were ex-

[14] We are frequently urged not to force the normal curve excessively. "The rôle of the normal distribution in statistics is not unlike that of the straight line in geometry; and we do not force curves into the mould of the straight line. Skew distributions are in fact the predominant type, for skewness arises from Lexian variability or nonhomogeneity, from Poissonian statistical rarity, from limitation in the number of causes of variation, and from nonlinear transformations of the scale." A. C. Aitken, *Statistical Mathematics*, New York, Interscience Publishers, Inc., 1942, p. 72. In our analysis, we have made use only of the latter possibility.

[15] The data for 1929 through 1939 are those published and discussed in the *Survey of Current Business*, Vol. 22, July, 1942, pp. 18–26; the data for 1940 through 1942 are from the June, 1943, issue of the *Survey of Current Business*, Vol. 23, pp. 10–22. A discussion of the problems encountered in estimating income by states is given by R. R. Nathan, "Some Problems Involved in Allocating Incomes by States," *Studies in Income and Wealth*, Conference on Research in National Income and Wealth, Vol. III, National Bureau of Economic Research, 1939, pp. 402–429. These estimates are necessarily fairly rough approximations, and there appears to be no way so far established of measuring the range of error to which they are subject. For those states that are heavily agricultural, the range of error would seem to be particularly large owing to the difficulty of estimating entrepreneurial withdrawals. Frequent revisions of the estimates have been made. Two different sets of estimates were published in 1940—in the April and October issues of the *Survey of Current Business*. Another revision



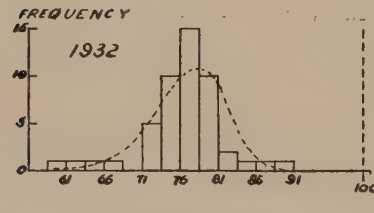


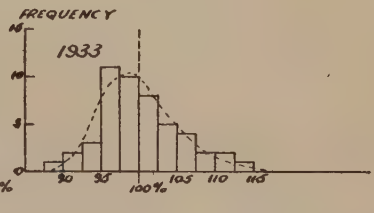
1930 as % of 1929	f_o	f_t		$\frac{(f_o-f_t)^2}{f_t}$
67– 70	2	1.34		
70– 73	0	0.79		
73– 76	1	1.47	9.15	0.14
76– 79	1	2.04		
79– 82	4	3.51		
82– 85	8	5.29		1.39
85– 88	8	7.53		0.03
88– 91	7	9.60		0.70
91– 94	12	9.78		0.50
94– 97	4	6.21		
97–100	0	1.42	7.65	0.36
100–103	2	0.02		

with 3 degrees of freedom, $\chi^2=3.12$, $P>0.3$

1931 as % of 1930	f_o	f_t		$\frac{(f_o-f_t)^2}{f_t}$
64.5–67.0	1	0.40		
67.0–69.5	0	0.35		
69.5–72.0	0	0.72	8.88	0.93
72.0–74.5	1	1.21		
74.5–77.0	2	2.31		
77.0–79.5	2	3.89		
79.5–82.0	7	6.06		0.15
82.0–84.5	13	8.78		2.03
84.5–87.0	10	10.33		0.01
87.0–89.5	7	9.11		0.49
89.5–92.0	5	4.80		
92.0–94.5	0	1.00	5.84	0.00
94.5–97.0	1	0.04		

with 3 degrees of freedom, $\chi^2=3.61$, $P>0.3$





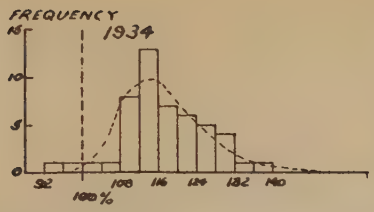
1932 as % of 1931	f_o	f_t		$\frac{(f_o-f_t)^2}{f_t}$
58.5–61.0	1	0.17		
61.0–63.5	1	0.26		
63.5–66.0	1	0.63	5.35	0.35
66.0–68.5	1	1.41		
68.5–71.0	0	2.88		
71.0–73.5	5	5.31		0.02
73.5–76.0	10	8.24		0.38
76.0–78.5	15	10.43		2.00
78.5–81.0	10	10.11		0.00
81.0–83.5	2	6.64		
83.5–86.0	1	2.47	9.54	2.16
86.0–88.5	1	0.41		
88.5–91.0	1	0.02		

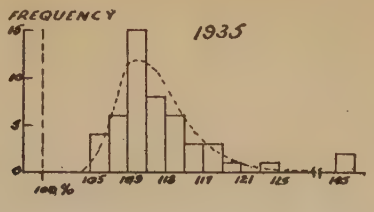
with 3 degrees of freedom, $\chi^2=4.91$, $P>0.1$

1933 as % of 1932	f_o	f_t		$\frac{(f_o-f_t)^2}{f_t}$
87.5– 90.0	1	0.19		
90.0– 92.5	2	1.69	7.31	0.23
92.5– 95.0	3	5.43		
95.0– 97.5	11	9.21		0.35
97.5–100.0	10	10.32		0.01
100.0–102.5	8	8.56		0.04
102.5–105.0	5	5.95		0.15
105.0–107.5	4	3.69		
107.5–110.0	2	1.99	7.65	0.24
110.0–112.5	2	1.02		
112.5–115.0	1	0.95		

with 3 degrees of freedom, $\chi^2=1.02$, $P>0.7$

FIGURE 3.—Annual frequency distributions of percentage changes of income payments by states compared with theoretical frequencies. (Observed frequencies denoted by histogram and f_o; theoretical frequencies by dotted curve and f_t. Curve fitted to percentage *changes*, and in table the theoretical frequencies in the extreme intervals include all beyond those intervals.)



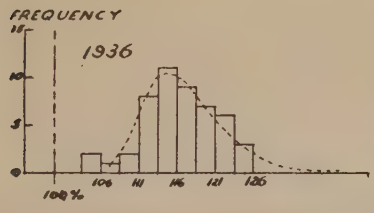


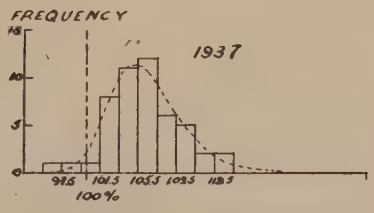
1934 as % of 1933	f_o		f_t		$\frac{(f_o-f_t)^2}{f_t}$
92– 96	1		0.00		
96–100	1	4	0.06	5.73	0.52
100–104	1		1.08		
104–108	1		4.59		
108–112	8		8.54		0.03
112–116	13		9.84		1.01
116–120	7		8.55		0.28
120–124	6		6.38		0.02
124–128	5		4.13		0.18
128–132	4		2.56		
132–136	1	5	1.47	5.83	0.00
136–140	1		0.81		
140–	0		0.99		

with 4 degrees of freedom, $\chi^2=2.04$, $P>0.7$

1935 as % of 1934	f_o		f_t		$\frac{(f_o-f_t)^2}{f_t}$
105–107	4	10	2.37	10.38	0.01
107–109	6		8.01		
109–111	15		11.77		0.89
111–113	8		10.85		0.75
113–115	6		7.49		0.30
115–117	3		4.25		
117–119	3		2.25		
119–121	1	10	1.08	8.51	0.26
121–123	0		0.51		
123–125	1		0.23		
125–	2		0.19		

with 2 degrees of freedom, $\chi^2=2.21$, $P>0.3$





1936 as % of 1935	f_o		f_t		$\frac{(f_o-f_t)^2}{f_t}$
103.5–106.0	2		0.02		
106.0–108.5	1	5	0.64	4.34	0.10
108.5–111.0	2		3.68		
111.0–113.5	8		8.14		0.00
113.5–116.0	11		10.27		0.05
116.0–118.5	9		9.37		0.01
118.5–121.0	7		6.92		0.00
121.0–123.5	6		4.42		0.56
123.5–126.0	3	3	2.57	5.54	1.16
126.0–	0		2.97		

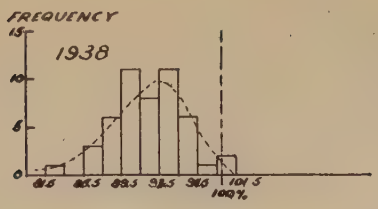
with 4 degrees of freedom, $\chi^2=1.88$, $P>0.7$

1937 as % of 1936	f_o		f_t		$\frac{(f_o-f_t)^2}{f_t}$
95.5– 97.5	1		0.01		
97.5– 99.5	1	11	0.42	10.95	0.00
99.5–101.5	1		2.84		
101.5–103.5	8		7.68		
103.5–105.5	11		11.01		0.00
105.5–107.5	12		10.69		0.16
107.5–109.5	6		7.59		0.33
109.5–111.5	5		4.58		0.04
111.5–113.5	2	4	2.34	4.18	0.01
113.5–115.5	2		1.84		

with 3 degrees of freedom, $\chi^2=0.54$, $P>0.9$

FIGURE 3 (continued).

appeared in August of 1941. The revision appearing in July, 1942, incorporated certain changes in definition, so that the estimates in some cases differed substantially from the earlier figures. It may be of interest that the same analysis as described in the following pages was first applied to the figures published in October, 1940, and the same conclusions were reached.

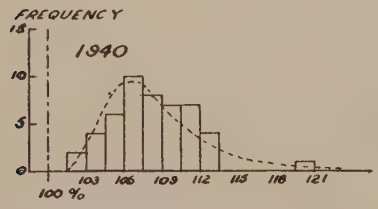


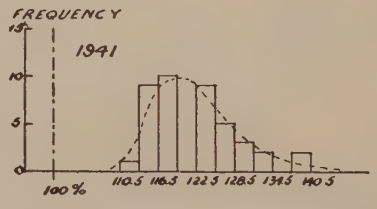
1938 as % of 1937	f_o	f_t		$\frac{(f_o-f_t)^2}{f_t}$
81.5– 83.5	1	1.88		
83.5– 85.5	0 } 4	1.78 } 6.85		1.19
85.5– 87.5	3	3.19		
87.5– 89.5	6	5.15		0.14
89.5– 91.5	11	7.65		1.47
91.5– 93.5	8	9.30		0.18
93.5– 95.5	11	9.37		0.28
95.5– 97.5	6	6.78		
97.5– 99.5	1 } 9	3.09 } 10.67		0.26
99.5–101.5	2	0.80		

with 3 degrees of freedom, $\chi^2=3.52$, $P>0.3$

1939 as % of 1938	f_o	f_t		$\frac{(f_o-f_t)^2}{f_t}$
99.5–101.0	1	0.01		
101.0–102.5	2 } 5	0.50 } 4.74		0.01
102.5–104.0	2	4.23		
104.0–105.5	8	9.35		0.19
105.5–107.0	11	10.99		0.00
107.0–108.5	11	9.14		0.38
108.5–110.0	8	6.27		0.48
110.0–111.5	3	3.76		
111.5–113.0	0	2.17		
113.0–114.5	1 } 6	1.20 } 8.51		0.74
114.5–116.0	1	0.64		
116.0–117.5	1	0.74		

with 3 degrees of freedom, $\chi^2=1.80$, $P>0.5$





1940 as % of 1939	f_o	f_t		$\frac{(f_o-f_t)^2}{f_t}$
101.5–103.0	2 } 6	0.88 } 5.64		0.02
103.0–104.5	4	4.76		
104.5–106.0	6	8.46		0.72
106.0–107.5	10	9.23		0.06
107.5–109.0	8	7.87		0.00
109.0–110.5	7	5.79		0.25
110.5–112.0	7	4.12		2.01
112.0–113.5	4	2.72		
113.5–115.0	0	1.84		
115.0–116.5	0 } 5	1.15 } 7.89		1.06
116.5–118.0	0	0.74		
118.0–119.5	0	0.50		
119.5–121.0	1	0.94		

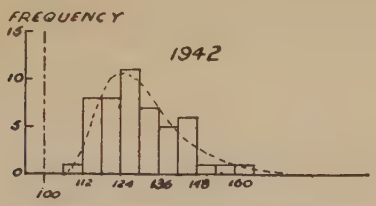
with 4 degrees of freedom, $\chi^2=4.12$, $P>0.3$

1941 as % of 1940	f_o	f_t		$\frac{(f_o-f_t)^2}{f_t}$
110.5–113.5	1 } 10	2.85 } 9.42		0.04
113.5–116.5	9	6.57		
116.5–119.5	10	9.49		0.03
119.5–122.5	8	9.67		0.29
122.5–125.5	9	7.63		0.25
125.5–128.5	5	5.37		0.03
128.5–131.5	3	3.32		
131.5–134.5	2 } 7	1.92 } 7.42		0.02
134.5–137.5	0	1.04		
137.5–140.5	2	1.14		

with 3 degrees of freedom, $\chi^2=0.66$, $P>0.8$

FIGURE 3 (continued).

pressed as percentages of those for the year preceding. The forty-nine percentages for each year were then rounded to whole numbers and formed into frequency distributions having class intervals of one. (The



1942 as % of 1941	f_o		f_t		$\frac{(f_o-f_t)^2}{f_t}$
106–112	1	9	0.83	6.44	1.02
112–118	8		5.61		
118–124	8		10.08		0.43
124–130	11		10.32		0.04
130–136	7		8.23		0.18
136–142	5		5.42		0.03
142–148	6		3.51		
148–154	1	9	2.09	8.51	0.03
154–160	1		1.19		
160–166	1		1.72		

with 3 degrees of freedom, $\chi^2=1.73$, $P>0.5$

FIGURE 3 (concluded).

tabular and graphic presentations have class intervals of three.) The means and standard deviations of these distributions were next computed. In addition, the conventional measures of skewness and kurtosis were computed by deriving R. A. Fisher's k-statistics and substituting in the formulae,[16]

$$g_1 = \frac{k_3}{{k_2}^{3/2}} \quad \text{and} \quad g_2 = \frac{k_4}{{k_2}^2}.$$

The measure of the kurtosis has been omitted from the table. An effort is made in Figure 2 to give a visual impression of a random or stochastic variable as a function of time—a developing series of frequency distributions. For convenience of presentation, the class intervals and the class limits of all of the distributions were made the same. Much

[16] R. A. Fisher, *Statistical Methods for Research Workers*, 7th ed., London, Oliver and Boyd, 1938, pp. 74–79. k is an unbiased estimate of the cumulant of the universe or population. The cumulants of the population are related to the moments about the mean as follows:

$$\mu_2 = \kappa_2, \qquad \mu_3 = \kappa_3, \qquad \mu_4 = \kappa_4 + 3\kappa_2^2.$$

The above formulae for skewness and kurtosis are seen to be identical with the standard ones,

$$\gamma_1 = \sqrt{\beta_1} = \frac{\mu_3}{{\mu_2}^{3/2}} \quad \text{and} \quad \gamma_2 = \beta_2 - 3 = \frac{\mu_4}{{\mu_2}^2} - 3.$$

The computation of the standard errors of g_1 and g_2 involves only the number in the sample, and the necessary formulae are in Fisher's discussion.

smoother distributions may be obtained by selecting class intervals for each distribution so that they are equal in terms of standard units rather than in absolute units, and such class intervals are approximated in Figure 3.

Attention may be called to several items in Table 2. In the first place, we find essentially the same movements as were shown in Table 1. This essential similarity may be seen by referring to the row labeled "weighted mean" toward the bottom of the table. In this row are given the percentage changes with reference to the summation of income payments for all forty-nine political divisions—that is, the percentage change of national income payments.[17] We may note that in three instances the mean of the distribution appears to differ significantly from the national percentage change. This latter, it will be recalled, is the weighted mean of the regional percentage changes, and its relationship with the unweighted mean is expressed by

$$K' = K + r\sigma_{\Delta Y_j/Y_j}\frac{\sigma_{Y_j}}{M_{Y_i}}$$

where K' and K are respectively the weighted and the unweighted means. In 1933 the unweighted mean of the variates was 100.2 with a standard error of 0.77, while the weighted mean was 97.2. In this year, there was little change in the average or the sum of income payments, this year being one in which income ceased its decline and began its absolute rise. We may say that there was a negative correlation between economic size of the region as defined and this percentage figure and either a negative correlation between economic size and the absolute *rate of rise* of income or a positive correlation between size and *rate of decline*. The economically larger regions showed on the average the more pronounced declines, and as a matter of fact most of the sparsely populated states of the Great Plains, the Rocky Mountains, and the Southwest were not showing rates of decline at all but instead rather marked rates of increase of income. The upper quintile of the array of the link relatives for this year was occupied by these sparsely

[17] Published figures for national income payments are not identical with the sums of income payments by states owing to the impossibility at present of distributing certain items by states. These items are normally unimportant relatively, and little difference would be made in the percentage changes whether one series or the other were used in computing these changes. For a statement of the content of state income payments and of the difference between national income payments and the sum of state payments see the *Survey of Current Business*, Vol. 22, July, 1942, p. 19 and nn. 1 and 2 on that page. The items whose state distribution is not at present feasible consist of such income as pay rolls of the army abroad, part of the pay roll of regional W. P. A. offices, a small amount of pensions, retirement pay, et cetera.

populated states, while the lower quintile was made up of the populous manufacturing states of New England and the Middle Atlantic together with Michigan and Illinois. In 1934 the difference between the weighted and unweighted means was about the same—approximately three standard errors—the rate of increase of the economically smaller areas being on the average somewhat greater. That year was one in which another group of sparsely populated states—in general, those of the Southeast—were showing extremely large increases while the behaviors of other sparsely populated areas were either conforming roughly with the average or were mutually compensating. In 1942 there was again a discrepancy of something more than three standard errors and again it is the sparsely populated states that make up the upper quintiles. In other words, in these years there was a significant bunching of economically small states on one side of the mean.

It may be suggested that if refined sampling techniques could be relied upon in the analysis of this type of data, an analysis of variance would very likely show no significant differences among these thirteen pairs of means. Yet, the present writer is uncertain about the interpretation of tests of significance in such a case as the present one. For these differences are not so interesting as magnitudes as they are as signs, and the differences, although small, are in every case in the direction that would fit the requirements of a hypothesis. The figures in Table 3 show the weighted and the unweighted mean rates of change

TABLE 3

WEIGHTED AND UNWEIGHTED MEAN RATES OF CHANGE OF INCOME PAYMENTS BY STATES

Year	K Unweighted Mean of Change	K' Weighted Mean of Change	Sign of r
1930	−12.3%	−11.2%	−
1931	−15.8	−15.5	−
1932	−23.4	−23.6	+
1933	00.2	− 2.4	−
1934	17.1	14.3	−
1935	11.7	10.7	−
1936	16.4	16.2	−
1937	6.1	6.4	+
1938	− 7.6	− 8.5	+
1939	7.1	7.0	−
1940	8.2	8.0	−
1941	22.1	20.6	−
1942	30.2	24.1	−

and the sign of the correlation coefficient between size of region and absolute rate of change. In ten of the years, neglecting criteria of significance, the economically smaller areas on the average showed greater rates of change than the economically larger areas. In the other three years, they showed smaller rates of change. But the timing of these latter years is interesting, for it will be noticed that the years in which the correlation is positive are the years in which *changes* in the rates of change are taking place and which preceded the years of absolute change in national income payments. The period is too short to justify a generalization, and the differences appear to be not statistically significant, but there is a suggestion here of a regional time sequence or pattern that might bear further study. For the economically small states happen to be primarily those sparsely settled states in the South, Southwest, Great Plains, and Rocky Mountain regions that specialize so predominantly in the agricultural and mineral raw materials. Like the shallow parts of a pond which freeze first, thaw first, and experience more rapid changes in temperature, the parts of an economy specializing in the upper stages of the structure of production appear to be the first to experience the slowing down of the rate of contraction and of the rate of expansion, and they seem to experience more rapid changes in income than appears to be the case with the parts of the economy specializing in the lower or "deeper" stages.

In the second place, there is a strong suggestion of a certain symmetry in these frequency distributions, a symmetry that at least points to the hypothesis stated at the end of the last section. This characteristic may be noted in the row labeled g_1 in Table 2 and in the shapes of the distributions in Figures 2 and 3. We have indicated a theory that implies a negative skew for these distributions when income is declining at an increasing rate or rising at a decreasing rate and a positive skew when income is declining at a decreasing rate or rising at an increasing rate. Disregarding again criteria of significance, we may notice that the first four years and the last five years show skews whose signs conform to these expectations. The first three years are years of increasing rates of income declines, and the skews are negative. The skew is positive for the year 1933, a year of declining income at a decreasing rate. The sign of g_1 for 1934 is not in conformance with the expectations of a positive skew, but the indicated skew is insignificantly small and is determined entirely by the extreme deviations registered by North Dakota, Nebraska, and Iowa. The casting aside of any one of these three would have been sufficient to render the skew a positive rather than the negative one. It is a little difficult to say what our theory would imply regarding the skew for 1935. The rate of rising showed a decrease, which would indicate a negative skew; but, on the other hand, within

the year the rate of change began a recovery that again carried it upward by 1936. The retardation of the rate of rising was not one preceding a downturn of income. At any rate the computation shows a positive skew. The figures for that year are not such as would elicit confidence. In that year the three states that were so extremely low in 1934 are the extremely high ones and substantially account for the positive skew. The behavior of the figures for these states in these years according to the 1942 estimates is almost the reverse of the behavior as recorded in the estimates appearing prior to those published in 1942. In 1936, the skew is negative rather than the expected positive, but again it is of insignificant magnitude and depends upon the extreme deviation of South Dakota. Moreover, each of the three states mentioned above shows practically as great a deviation as South Dakota and any one could nearly account for the negative sign. The year 1937 should show a negative, but it shows an insignificant positive skew, this direction being possibly accounted for by a single state, again North Dakota. The rest of the years indicate skews that conform with the theory. For the four nonconforming years the magnitudes of the skews are not large enough to be considered significant (with the exception of 1935) and depend in each case upon the extreme behavior of one or two of the same group of states. It should be borne in mind that our hypothesis involves the "normal" conditions, one of which requires many causes of variations no one of which exerts a large effect. During these years of apparent nonconformance, these Middle Western plains states were greatly affected by an unprecedented drouth which in itself could be the basis of a skew. Nine of the years are in clear conformance with the theoretical expectations. The computations of four of the thirteen years do not give so clear a picture.

Thus, it would appear that some such systematic skew as suggested by the theory is in evidence, and regarding this skew it may be in point to note again the observation made above. Table 2 does not identify the extreme deviations by states but were this the case it would be seen that a certain group of states accounts in general for these extremes. These states are those of the South, of the Great Plains, and of the Rocky Mountain regions—all specialists in agricultural or extractive raw materials. These states appear to be the lead-off group when a shift takes place in the direction of change of the rate of change of national income. Moreover, they generally constitute the tails of the distribution in the years other than those in which a change of direction is developing.

The portrayal of the systematic skew apparently characterizing these frequency distributions may be carried further by fitting theoretical curves, and the results of this operation are shown in Figure 3. These

frequency distributions are the same as those presented in Table 2 and Figure 2 except that the class interval has been made approximately equal in each case to one-half the standard deviation for that year. Inasmuch as the dispersion varies considerably over the years, the class intervals of the distributions in Figure 3, although approximately constant in terms of standard units, vary in absolute terms as between the years. A logarithmic normal distribution was fitted to each of these distributions,[18] and the theoretical frequency is represented by a light dotted line indicating the shape of the theoretical frequency curve. The distributions were fitted not to the link relatives but to the percentage rates of change. The chi-square test shows no significant discrepancies between the observed and the theoretical frequencies, but these tests are presented only as rough guides to aid the reader in obtaining a visual conception of the typical shape of these distributions. The fit, as we have made the computations, is in certain cases not a logarithmic fit to merely the rates of change. In the case of 1930, for example, two states showed gains of approximately 1 per cent while all others showed declines. In order to obtain a series in which each member has the same sign, 3.5 was subtracted from each percentage rate of change. Thus, in this case a logarithmic normal curve has been fitted to a linear transformation of the rates of change rather than to simply the rates of change, an operation that will reduce the skew of the fitted curve. This problem of the existence of different directions of change was not involved in the case of 1931, 1932, 1935, 1936, 1940, 1941, and 1942, and to the data of these seven years a straightforward fitting of logarithmic distributions was made. In the cases of 1930 and 1939, the amount added to each percentage (3.5 and 1, respectively) is not so large as to make a noticeable difference in the fitted distributions. To the percentages of the other four years the amounts added are substantial. To those of 1933, 20 was added; to those of 1934, 10 was added; in the case of 1937, 10 was added; and in the case of 1938, 10 was subtracted. These constants used were not systematically selected but simply chosen for the innocent purpose of rendering all the signs the same. But visually, the shapes of these latter distributions are pretty obvious, and they appear to fall into the same general pattern formed by the distributions of the other years. The years 1930, 1931, and 1932 show negative skews and a reasonably close fit to the theoretical distributions. The negative skews are in line with our expectations. As we should expect, 1933 clearly shows a positive skew, and the shape is suggestive of a logarithmic fit, even though the fit actually

[18] The method used is that of Professor G. R. Davies as described in Frederick E. Croxton and Dudley J. Cowden, *Applied General Statistics*, New York, Prentice-Hall, Inc., 1939, pp. 295–299.

made is in large measure vitiated by the arbitrary adding of the relatively large constant. In this case the use of a smaller constant would have improved the fit. The year 1934 conforms to expectations, although the adding of a constant again renders the indicated fit somewhat misleading. The year 1935 clearly shows a positive skew and a pretty close logarithmic fit, although, as observed above, the behavior of income in this year is somewhat difficult to interpret for the purposes of our theory. To the data of 1937, 10 was added, thus making all of the rates to which the distribution was fitted positive. As a consequence the fitted curve has a moderate positive skew. But to the eye the observed distribution shows little evidence of a skew in any direction, and again the year is hard to interpret. Likewise, to the eye 1938 shows little skew, although we should perhaps expect a positive skew. In the cases of all the other years, the skews are in the expected directions and the fits are quite suggestive. Again, we should observe that the chi-square test is meant for nothing more than an aid and guide for the eye, inasmuch as the smallness of the frequency and the nature of the data render such a test of doubtful validity.

So far we have called attention to the correspondence between the rate of change of the series of national income payments and the unweighted mean rate of change of the income payments of the component parts of the nation and to certain uniformities in the frequency distributions formed from regional rates of change. We may make one further observation. There appears to have occurred during the decade of the thirties a rather striking decline in the dispersions of these frequency distributions. If we observe the row in Table 2 giving the dispersion of the distributions, a discontinuous decline may be noted as occurring about in 1935. On the average, the distributions of the first five years show dispersions that are practically twice the average dispersion for the next six years—that is, through 1940. The circumstances affecting the extent of the variation of the dispersions of these distributions must be very complex indeed so that nothing very simple either one way or another could be said with much point at this time. One is tempted, however, to suggest that the numerous and novel techniques of monetary and fiscal policy that have been made available during the latter six-year period are used as compensatory as well as stimulating devices, and their natures are such that their use might tend to keep together the movements in the different areas. But then, we will notice that beginning in 1941 with the abnormal rises of income consequent upon war expenditures the dispersions again are widening out. This behavior at least suggests a functional relationship between the magnitude of the dispersion of these distributions and the intensity of the change in process. Thus, it is suggested that secular changes may take

place that alter the extent of the variation of the regional rates around the national rate of change, but that, given an economic structure, a functional relationship exists between the magnitude of the dispersion and the magnitude of the rate of change. As more data become available an inquiry may be made regarding the relationships involved and the factors underlying the size of the dispersions of these distributions.

6. TENTATIVE INFERENCES FROM THE STATISTICAL ANALYSIS

In regard to our hypothesis stated in the earlier section what inferences are suggested by the above statistical analysis?

First, in view of the correspondence between the national rate of change of income and the unweighted mean of the regional rates of change and in view of the fact that the latter constitutes a measure of the central tendency of a frequency distribution having a characteristic shape, it seems valid to regard the national rate of change of income as a measure of central tendency of a frequency distribution of regional rates of change.

Second, these frequency distributions appear to have a characteristic shape suggestive of a logarithmic normal curve.

Third, the evidence suggests some systematic determination of the direction of the skew. So far as sustained movements are involved, the skew appears to conform to the theoretical expectations of the third part of the hypothesis. Where short-lived shifts occur in the direction of change of the rate of change of income (e.g., in 1935) the evidence is not so clear. An analysis using shorter periods of time may throw light upon the evolution of the shape of the frequency distribution when national income undergoes erratic movements. It is suggested that in such periods other types of causes, inappropriate to the normal hypothesis, may be in operation.

In connection with these skews, it may be noted that the extreme movements from year to year are found generally among the same set of states. The bunching of these states in one tail of the distribution characterizes a year of marked change. Years of relative stability are characterized by what appears to be a roughly U-shaped distribution of these more volatile states along the entire range of variation.

In addition to the above observations, it may be mentioned again that the dispersion of this distribution appears to be functionally related to the intensity of change in process in the nation, although secular or discontinuous changes may occur to alter the typical or representative magnitude for this dispersion.

It should be remarked that in the above analysis states are being conceived of in a manner that was thought to leave an incomplete impression when the national area alone is considered. That is, a single

figure is assumed to represent the direction and intensity of business change in an area bounded by states lines; yet this figure too would in fact be merely a parameter of a frequency distribution showing a dispersion around a central tendency. We cannot escape the fact of the component parts even of a more plausibly defined "economic region." The fundamental unit in the mechanism of income disbursement is the individual firm, and at any point of time within any defined area variation will be in evidence in the rate and direction of change of income payments by these units. The challenging problem in this connection, with which we shall try to deal in a subsequent paper, is to define an *area* unit that may be given an interpretation as a unit in an analysis of the regional diffusion of short-run economic change. Variation should be classified, here as elsewhere, and analyzed into its sources. Our area units should be designed to provide a comparison of variation within with variation between that will throw light upon regional differences in cyclical responsiveness and upon the mechanism by which economic shocks are propagated or diffused throughout a larger area.

University of Virginia

Reprinted from
ECONOMETRICA, Journal of the Econometric Society, Vol. 14, No. 1, January, 1946
The University of Chicago, Chicago 37, Illinois, U.S.A.

LOCATION OF INDUSTRY AND REGIONAL PATTERNS OF BUSINESS-CYCLE BEHAVIOR

By RUTLEDGE VINING

In a recent paper[1] we presented the first stage of a statistical inquiry into the nature of the abstraction involved in the use of national series for the description and analysis of business cycles. The results were given of an analysis of one aspect of the cyclical behavior of national income—its percentage rate of change. This rate of change of the national total was interpreted as a parameter of the frequency distribution of the respective rates of change of the component parts of the larger area, and statistics describing a certain pattern of behavior of these distributions were shown. The distributions appear to have a characteristic shape approximating logarithmic normality, and there is a suggestion of a systematic development as the different phases of the business cycle unfold. The skews of the distributions appear to be positive during the period of the expansion when the rate of growth is increasing. When the rate of growth begins to decline, it was tentatively suggested that the skew shifts to a negative and remains a negative through the absolute turning point of national income and during the period when the rate of contraction is increasing. When this rate of contraction begins to decline, the skew of the distribution again shifts to the positive. An attempt was made to rationalize this cyclical evolution of shape of these distributions. It was further noted that the extreme movements from year to year are found generally among the same set of states, there being a tendency evident for the more sparsely settled states that are highly specialized in raw-material production to cluster in the ends of the distribution and, in years of marked change, in the same end of the distribution.

It is proposed in the present paper to discuss in more detail the geographical make-up of these annual frequency distributions of regional rates of business change. We think that certain generalizations may be made regarding a regional pattern of short-run business change, and we should like to analyze possible factors that might account for the observable similarities and differences. Our previous discussion of the factors determining the cyclical responsiveness of a given region laid emphasis upon industrial location or specialization and the institutional and physical factors influencing the region's commercial ties. The question we raise now has to do with certain attributes of industrial location that we regard as particularly relevant for regional business-cycle analysis.

[1] "Regional Variation in Cyclical Fluctuation Viewed as a Frequency Distribution," ECONOMETRICA, Vol. 13, July, 1945, pp. 183–213.

1. REGIONAL ECONOMIES IN INTRANATIONAL BUSINESS-CYCLE ANALYSIS

In the present paper, as in the paper cited, we shall work with state data, but it may be indicated here that states are not what we shall regard in later work as "regional economies." A state generally will be found to include parts of several "regions" such as we should like to consider as units for regional business-cycle analysis. It is the "natural" trade area familiar to marketing specialists that would seem to be the more practicable representation of our unit. It is not surprising that buying habits and commercial contacts develop that tie the business units of an area to a particular trading center. There must be an agglomeration tendency here just as there is in manufacturing industry. In the latter field, repair and machine-shop facilities, technological skills, communication and transportation facilities that develop to serve one firm or industry in a given locality are available for other firms or industries. This is part of the working of the principle of external economies. That is, many such facilities are "lumpy" and discontinuous in size, and the unit of optimum size for efficient operation is larger than required to meet the demands of one firm or industry. It becomes easier and less costly to establish a firm or industry in an area after other firms and industries have been established. Thus it must be with commercial and marketing facilities. Banking, brokerage, wholesaling, and other business services agglomerate in a trading center, through which the "export" commodities of an area are passed to the "outside" world and through which the "imported" commodities—the "exports" of other regions—are drawn for distribution within the area. This is not to say that no interregional trade goes on except through the trading centers, and we do not object to our boundaries being zones rather than lines. We are saying merely that the great bulk of the products of certain types of industry of a particular area are channeled through a population concentration that is regarded by the inhabitants of the area as the trading and financial center. Of particular importance are the banking connections within these units. The ebb and flow of a region's liquid funds is reflected in the reserve experience of particular banks, whose spatial sphere of operations is fairly definite.

Now if it were true that all economic enterprises of one of these units could be neatly classed into those employments whose products are sold and consumed locally and those whose products are exported to other areas, a relatively simple analysis of regional differences in cyclical responsiveness would be suggested. If it were found that each region's "export" employment was confined to the production of one product whose consumption market encompasses the entire greater area made up of the interlocking regions, the analysis would be yet simpler. From

one point of view, the home-market employment could be thought of as employment that is auxiliary to and a part of the export industry. Just as independent machine shops in areas specializing in lumber production could be considered as a part of the lumber industry, so might we consider the bakery establishments and retail marketing services to be auxiliary employment to the lumber industry. The existence of the lumber industry in that area would imply the existence of these other enterprises, but the converse of this statement would obviously not be true. From this point of view, we could regard this whole class of home-market industries or employments as unique in that a home-market industry may be physically but not economically quite the same from region to region, being closely tied in each region to the "export" industry. Thus, while an export industry or employment might show regional uniformity in its behavior, being affected similarly regardless of location, the cyclical behavior of home-market employment would show more or less wide regional differences, such industries in each region assuming certain of the cyclical characteristics—in more or less diluted form—of the export industry of that region. The feature that would make for regional differences in business-cycle behavior would consist largely of the varying income elasticities of the different "export" products. The demand for the "export" product of some regions would be little affected by the business cycle so that the purchasing power would be sustained with little decline during a national business depression. The demand for the "export" products of other regions would be very drastically affected by the business cycle so that purchasing power in such regions would fall greatly in national business depressions and rise greatly in national business expansions. The regions that would be affected most would be those whose "imports" are "necessities" that would decline little in use in a depression and whose "exports" are durable, storable commodities whose demand would fall to a low level in a depression. Under these conditions, money payments to the rest of the nation would not be easily adjusted to the falling money receipts from the rest of the nation, local banks would rapidly lose reserves to other regions, and local purchasing power would continue to decline until ultimately purchases are choked off to equal money receipts. If the reverse of these conditions were satisfied in a given region, that region would show relatively small declines in national depressions and would tend to gain banking reserves during those times.

The above is a sketch of a conceptual framework that has given a semblance of direction to our statistical inquiries. It is obviously not true that a particular area specializes in but one "export" product, but by and large it will be found that the specialization is frequently quite

marked. It is also not true in general that "export" products have nation-wide markets, but it is the case in many instances, and at least the structure of these regional interlocks may be investigated. Finally, as was indicated, a state is not what we should regard as an "economic region" and will generally include parts or the whole of several integrated trade areas; and the behavior in the business cycle of state figures will be a sort of average of the behavior of the figures of its component regions. States comprised of economically similar regions should show a similarity of behavior in the business cycle. Statistics descriptive of industrial location by states should indicate how a particular state might be expected to respond in a business cycle and should help explain observable geographical patterns of business-cycle response.

2. CERTAIN RELEVANT FEATURES OF INDUSTRIAL LOCATION

In our study of industrial location we have made an adaptation of certain techniques of Professor Sargant Florence. On the basis of occupations statistics for Great Britain and the United States, Florence has set apart a class of industry that he designates as "residentiary" or "ubiquitous" industry[2]—residentiary in the sense that they typically reside where the consuming population resides. With reference to a given region, the industries other than the residentiary ones are called the "primary" industries. Industries are classified into one or the other of these types on the basis of a measure devised by Florence and called the coefficient of localization.[3] For each region a "location factor" is computed for each industry by obtaining the ratio of the percentage of total employment in the given region found in the given industry to the same percentage for the nation as a whole. If the industry were perfectly uniformly distributed among all the regions all the regional location factors would be unity. If the industry were highly localized in a very few regions, these few regions would have high location factors for that industry, and the rest of the regions would show location factors that are small or zero. The *coefficient of localization* for a given industry is obtained by computing the weighted avergage deviation from unity of the location factors for all the regions, the weight for each region being the proportion of total national employment found in that

[2] A. J. Wensley and P. Sargant Florence, "Recent Industrial Concentration, Especially in the Midlands," *Review of Economic Studies*, Vol. 7, June, 1940, pp. 139–158; P. Sargant Florence, "Memorandum on Long Range Planning," Mimeographed Release of the National Resources Planning Board, 1940, pp. 14–30; P. Sargant Florence, "Geographical Distribution of Economic Activity among Broad Industry Groups," Mimeographed Release of the National Resources Planning Board, 1940, pp. 1–24. By "industry" is meant any specific type of economic production so that the term includes agriculture and trade.

[3] Florence, "Memorandum on Long Range Planning," pp. 19–25.

region. This measure divided by two varies between zero and unity.[4] The coefficient of localization measures complete uniformity of geographical distribution as zero As greater and greater geographical concentration is encountered, the measure approaches unity. The coefficient for automobile repair shops in 1930 as computed by Professor Florence using state data, for example, was 0.068. The coefficient for automobile manufacture was 0.597. Automobile repair shops are relatively uniformly distributed over the nation. Automobile manufacture is highly localized.

[4] Identical results are obtained by "adding the plus differences (or, since they total the same, the minus differences) of the local percentage of workers in the *given* industry from the local percentage of workers in *all* industry." *Ibid.*, p. 19. These measures may be presented symbolically as follows:

Let E = Total gainfully employed in Nation,
E_a = Total employed in Industry a in the Nation,
e_1 = Total employed in Region 1,
e_{1a} = Total employed in Region 1 in Industry a.

The location factor of Industry a in Region 1 is defined as

$$\frac{\frac{e_{1a}}{e_1}}{\frac{E_a}{E}}.$$

The coefficient of localization is computed as follows:

(1) Region	(2) Location Factor	(3) Weighted Deviation from Unity
1	$\frac{e_{1a}}{e_1} \div \frac{E_a}{E}$	$\left(1 - \frac{\frac{e_{1a}}{e_1}}{\frac{E_a}{E}}\right)\frac{e_1}{E} = \frac{e_1}{E} - \frac{e_{1a}}{E_a}$,
. . . . .		
n	$\frac{e_{na}}{e_n} \div \frac{E_a}{E}$	$\left(1 - \frac{\frac{e_{na}}{e_n}}{\frac{E_a}{E}}\right)\frac{e_n}{E} = \frac{e_n}{E} - \frac{e_{na}}{E_a}$,
Coefficient of Localization = ...		$\sum_1^n \left\lvert \frac{e_i}{E} - \frac{e_{ia}}{E_a} \right\rvert$.

The algebraic sum is obviously zero, indicating the equality of the positive and negative deviations. The absolute sum, disregarding signs, varies from zero to two. If in each region the two percentages are identical—i.e., if the industry were perfectly uniformly distributed—then the sum of the deviations is zero. If all of the given industry is located in a single region, and if regions and industries are so defined as to be of negligible size relative to the total economy, then the absolute sum of the deviations will approach two as a limit.

The residentiary industries are those with "low" coefficients of localization—that is, those that are uniformly distributed according to population and that depend upon local markets for the disposal of their products. The residentiary service industries include gas, water, and electric utilities, transport, trade, and finance, professional services, entertainment, and personal services. In addition, "many manufacturing industries show extremely low coefficients and resemble in this the residentiary service industries."[5] The work of Florence evidences the relative stability, as between regions, of the proportion of total employment found in these residentiary industries. Obviously, the magnitude of this proportion depends in some measure upon the principle according to which regions are delineated, for the larger the area representing a "region" the broader will be the category referring to residentiary manufacturing industries. But for a defined set of areas, the location factors of certain employments will show a strong concentration around unity, and the percentage of total employment found in this list of employments will vary from region to region within a relatively narrow range.

It is the character of the rest of the employment that would seem to differentiate regions or states with respect to their cyclical responsiveness. The residentiary industries we may call the "passive" industries, for these industries typically play a passive role in the short-run process of business change in a given region. Local income constitutes the market for their products, and they move along *with* the general business activity of the region. The primary industries we may call the "carrier" industries—by analogy from the fields of mechanics or of chemistry or of medicine. These industries are those that typically depend for their markets upon the income of other regions and are the media by which economic change is transmitted from region to region. Economic change capable of affecting national income initially impinges upon certain industries located in certain regions. The changes that are brought about in these industries are propagated to other regions and diffused over the entire national area (or over the entire economically related area) by way of the effect of these initial changes upon the expenditures on products of the primary industries of other regions. The primary industries are the connecting links; the residentiary industries are passive in this process of interregional diffusion of economic change.

Using quite simple methods of analyzing the occupational statistics of the states of this nation, we may present concretely some idea of

[5] "Instances are building, baking, repair work, job-printing, and it is clear that such production has to be located where the population is, because of heavy transport cost in relation to value of commodity, because of its perishability, because of need for close communication with the customer." *Ibid.*, p. 20.

these features of industrial location. For this purpose, we arrayed for each industrial classification the state figures for the percentage of total employment found in that industry.[6] For each of these arrays the range limits of each quintile interval were located, and these range limits and the median figure were then divided by the appropriate national percentage. The results of this procedure are shown in Table 1. This table provides certain points on the array of state location factors for each industrial classification, and these latter are arrayed from top to bottom, in the order of what appears to be the degree of localization. The table shows approximately that which Florence's coefficient of localization shows in a much more condensed form, and for its awkward bulkiness it may possibly offer compensation in the form of an enhanced visual impression of the character of industrial localization.

For our purposes, these data are fraught with shortcomings, and it may be instructive to refer to the implications of a few of these deficiencies. If the subareas under study were approximately of equal "economic size" and small relative to the total area, if the standards of living and consumer tastes were approximately uniform as between regions, if industrial classifications were fine enough drawn in order to provide internal uniformity, then we might possibly rationalize an expectation for a certain general pattern to be exhibited by the columns in this table, the industries being arrayed in order of degree of localization. The market areas of different products would obviously show wide differences. Suppose we should measure the typical market area of a product by some average distance between the point at which the value is added and the point of final consumption. A frequency distribution of these variates, typical distance for each defined product, could be constructed, but it would be difficult to anticipate the general shape of this distribution. If it were U-shaped it would mean that a relatively large proportion of products are sold at a point close to their respective points of production, a relatively small proportion at intermediate distances from these points, and another relatively large proportion sold in all corners of the national area. If it were a single-humped distribution, it would mean that there is a concentration point for market area distances and that extreme distances on either side of the concentrat on become progressively less frequent. Those products, or value-additions, whose market areas encompass the entire nation must of course be the highly localized industries—some sharp production advantage being found at certain points or centers within the larger area. Around and among those primary clusters will have been built up industries with trade areas of intermediate length, and with each popu-

[6] The data analyzed were from the *Sixteenth Census of the United States: 1940. The Labor Force—Employment, Unemployment, Occupation, Income, by States*, Vol. IV. Washington, Government Printing Office, 1941.

TABLE 1

RATIOS OF PERCENTAGE EMPLOYED IN STATE TO PERCENTAGE EMPLOYED IN NATION BY INDUSTRIES IN 1940

Industrial Classification	No States Less Than	Three States Less Than	20% of the States Less Than	40% of the States Less Than	50% of the States Less Than	60% of the States Less Than	80% of the States Less Than	All But Three States Less Than	All But One State Less Than
1. Autos and Auto Equipment	0.00	0.00	0.00	0.08	0.08	0.15	0.36	0.62	15.00
2. Coal Mining	0.00	0.00	0.00	0.00	0.00	0.33	1.25	4.00	17.00
3. Crude Oil and Natural Gas Products	0.00	0.00	0.00	0.00	0.00	0.25	2.50	5.00	11.25
4. Leather and Leather Products	0.00	0.00	0.00	0.13	0.13	0.38	1.13	3.25	15.38
5. Transportation Equipment (Except Autos)	0.00	0.00	0.00	0.14	0.29	0.43	1.14	3.00	3.57
6. Non-ferrous Metals and Products	0.00	0.00	0.00	0.33	0.50	0.83	1.50	3.00	10.33
7. Iron and Steel and Their Products	0.00	0.04	0.07	0.21	0.25	0.50	1.25	2.25	3.14
8. Machinery Mfg.	0.04	0.04	0.08	0.21	0.21	0.50	1.29	2.08	3.04
9. Textile Products and Apparel Mfg.	0.00	0.00	0.07	0.23	0.28	0.51	1.70	2.42	5.28
10. Paper and Allied Products	0.00	0.00	0.14	0.43	0.57	0.71	1.29	2.71	7.14
11. Chemicals and Allied Mfg.	0.00	0.00	0.20	0.40	0.50	0.80	1.20	2.20	9.00
12. Petroleum and Coal Products	0.00	0.00	0.25	0.50	0.50	1.00	2.25	3.25	4.25
13. Logging, Sawmills, and Planing Mills	0.00	0.08	0.31	0.62	0.62	1.39	2.39	2.92	8.69

TABLE 1 (concluded)

14. Stone, Clay and Glass Products	0.00	0.14	0.43	0.57	0.57	0.71	0.86	2.29	4.71
15. Other Mines and Quarries	0.00	0.25	0.50	0.75	0.75	1.00	3.00	13.25	37.50
16. Furniture and Misc. Wooden Goods	0.00	0.13	0.38	0.75	0.88	1.00	1.50	2.13	2.75
17. Agriculture	0.01	0.17	0.57	0.92	1.28	1.61	1.94	2.60	3.12
18. Printing and Publishing and Allied Mfg.	0.21	0.29	0.50	0.64	0.64	0.86	1.00	1.36	2.21
19. Finance, Insurance, and Real Estate	0.25	0.41	0.53	0.63	0.75	0.84	1.06	1.47	1.88
20. Domestic Personal Service	0.39	0.46	0.69	0.79	0.87	0.92	1.35	1.69	2.08
21. Amusement, Recreation, etc.	0.33	0.56	0.67	0.78	0.78	0.89	1.00	1.33	3.00
22. Food and Kindred Products Mfg.	0.33	0.46	0.50	0.75	0.83	1.04	1.29	1.38	1.67
23. Communications	0.33	0.44	0.67	0.89	0.89	1.00	1.11	1.33	1.56
24. Government	0.47	0.67	0.83	0.97	0.97	1.08	1.33	1.86	2.44
25. Wholesale Trade	0.44	0.56	0.67	0.82	0.85	1.04	1.22	1.37	1.63
26. Utilities	0.42	0.50	0.75	0.92	0.92	1.08	1.25	1.33	1.50
27. Construction	0.44	0.70	0.87	0.96	0.98	1.07	1.15	1.39	1.61
28. Transportation	0.44	0.56	0.79	1.00	1.04	1.10	1.23	1.38	2.02
29. Other Personal Service (Laundries, Hotels, etc.)	0.57	0.70	0.78	0.89	0.92	1.00	1.14	1.38	1.70
30. Business Serv. and Repair Serv. (Including Auto Repair)	0.47	0.58	0.84	1.00	1.00	1.11	1.16	1.21	1.42
31. Professional and Related Services	0.58	0.69	0.89	1.00	1.01	1.07	1.16	1.25	1.33
32. Retail Trade	0.50	0.64	0.79	0.94	0.99	1.03	1.09	1.14	1.25

lation aggregate will be the service and other industries with the extremely short trade radii. Thus, an ideal Table 1, it might be supposed, would show the most highly localized industries as lacking altogether in many regions. Only a few regions would show as great relative employment in these industries as does the nation, and a very few would show a relatively high proportion of their employment in these industries. The products of these industries would be import products for nearly all of the regions of the nation. As the industries become less localized (as the typical trade radii become smaller), fewer regions would lack the industries altogether, more regions would move into the exporting class, and the location factors in the specializing regions would become smaller. The "ideal" Table 1, that is, might suggest a surface. Thus, starting with the upper left-hand corner (with the most highly localized industries) and moving horizontally across the cumulative distribution of regions, this surface would move along the zero line leaving it relatively late but finally climbing very rapidly to a height sufficient to make the area under the traced-out line equal to unity[7]—the latter condition always being the case. For the next most highly localized industry, the surface would leave the zero line slightly earlier and climb somewhat less rapidly to a height somewhat lower than the industry just preceding. At length, we should exhaust the list of industries that are entirely lacking in at least one region, and as we move down the array of industries we should approach that list of industries that would be represented by a height of unity over the entire range of regions. That is to say, the first columns would show a continuous rise to the neighborhood of unity. Then for a while the columns would rise to a maximum and then decline to the neighborhood of unity. Finally, the columns would decline continuously and approach unity.

The conditions to which the data in the actual Table 1 are subject diverge in great measure from those outlined in the second sentence of the preceding paragraph. The states show vast differences in size so that industries highly localized in large states show much smaller maximum location factors than industries equally highly localized in small states Average income, living standards, and consumer habits differ importantly from region to region so that employment that is necessarily residentiary is of varying relative importance from region to region. The industrial classifications are very broad and obviously lack internal homogeneity so that in certain cases the location factors are rendered quite ambiguous by the inclusion of uniformly distributed employment

[7] If the regions were of equal size in terms of employment, the simple mean location factor would be unity. That is, the mean ordinate under the curve would be one, and the base of the figure would extend from zero to 100 per cent. The mean ordinate would also be unity if the regions were not of equal size, provided there is zero correlation between size and the magnitude of the location factor.

and highly localized employment within the same industrial classification. Nearly all of our industrial classifications would show in some degree this ambiguity. But the industries ranked fourteenth, fifteenth, seventeenth, and twenty-second in Table 1 are especially outstanding instances of internal heterogeneity. Clay and brick-making material for regions as large as states is almost "ubiquitous" material and the heavy transportation charges result in certain subclasses of "Stone, Clay, and Glass Products" manufacturing being residentiary. On the other hand glass manufacturing appears to be relatively highly localized. Nonferrous-metals mining is very highly localized, but other subclasses of "Other Mines and Quarries" are residentiary. "Agriculture" is no more a single industry than is "Manufacturing," and the production of certain extremely important agricultural products is highly localized, while certain other subclasses are residentiary. Such "Food and Kindred Products" manufacturies as bakeries and ice plants are residentiary, but other subclasses show high localization.

Nevertheless, Table 1 shows roughly the characteristics of our hypothetical surface. Were we to omit the ambiguous classifications noted above, the similarity would be almost striking, considering the other discrepancies in the underlying conditions. The degree of localization shades off gradually from the employments that are virtually independent of local demand, through those that produce exportable products for which the local demand is not negligible, to those finally that are virtually wholly dependent upon local demand. From this table a rough classification may be made and a fairly good conception may be obtained of the relative importance of the "carrier" industries within a given state. Referring to the table, we may set apart the following industries as the "passive" industries. At the right of each industry the median state percentage of total employment is given:

Retail Trade	13.8%
Professional and Related Services	7.4
Business Service and Repair Services	1.9
Domestic Personal Service	4.5
Other Personal Services (Laundry, Hotels, etc.)	3.4
Transportation	5.0
Construction	4.5
Utilities	1.1
Wholesale Trade	2.3
Government	3.5
Communications	0.8
Food and Kindred Manufacturing	2.0
Amusement, Recreation, etc.	0.7
Finance, Insurance and Real Estate	2.4
Printing and Publishing	0.9
	54.2%

TABLE 2

QUINTILE INTERVALS* IN THE ANNUAL ARRAYS OF ANNUAL STATE INCOME PAYMENTS EXPRESSED AS PERCENTAGES OF YEAR PREVIOUS

Year	1st Quintile interval	2d Quintile interval	3d Quintile interval	4th Quintile interval	5th Quintile interval
1930	69.03– 82.64%	82.90– 86.27%	86.35– 90.38%	90.94– 92.96%	93.38–101.24%
1931	66.81– 81.23	81.51– 83.38	83.66– 85.33	85.45– 88.23	88.50– 95.79
1932	59.91– 73.75	74.19– 75.85	76.26– 77.53	77.71– 80.76	80.82– 88.62
1933	89.90– 96.30	96.44– 97.38	97.71–100.61	100.67–103.44	104.32–113.77
1934	92.80–111.29	111.59–112.76	112.98–119.35	119.45–124.21	124.31–136.53
1935	105.88–109.04	109.61–110.31	110.42–112.46	112.81–114.53	115.43–145.81
1936	104.95–113.11	113.24–115.53	115.59–117.58	117.82–119.84	120.41–124.65
1937	96.18–103.14	103.25–104.72	105.24–106.93	107.00–108.46	109.04–115.31
1938	83.15– 89.26	89.55– 91.38	91.51– 93.75	93.93– 95.49	95.63–101.40
1939	99.85–104.99	105.12–106.46	106.50–107.34	107.41–108.87	109.13–117.57
1940	102.73–105.57	106.18–106.87	107.12–109.07	109.24–110.53	110.89–121.13
1941	113.42–116.29	116.93–119.38	119.53–122.23	122.68–126.41	128.35–140.24
1942	108.58–116.84	120.11–127.48	127.87–130.36	131.79–142.81	146.16–166.72

* These are not in all strictness quintile intervals. Actually, the object was to divide the states of each annual array into five equal groups, and these intervals represent the limits shown by these groups. Some discretion was exercised where the variation between states at these limits was so insignificantly small as to render arbitrary the placing of a state in one "quintile interval" rather than in the following one. For example, of the 65 groups, 7 contain but 8 states and 7 contain 12. One group contains but 7 states.

The percentages shown represent, of course, the central tendency around which the figures for the various states are dispersed. If a given state's dispersion around these central tendencies is random, then we may say that in the neighborhood of 55 per cent of a state's total employment will be found in these industries that are pretty definitely residentiary or passive. Actually, there is good reason to think that a state's deviation from the central tendency is not random and that those states with the higher per capita income tend to fall to the right of the central tendency, so that the aggregate percentage in this list of employment would bear a direct relation with the standard of living. As the per capita income of a region rises there seems to be a tendency to allocate more of its resources to service industries. But the 55-per-cent figure gives an approximate conception of the relative importance of these residentiary industries in a state's total employment. To this figure should be added a certain proportion of total employment that is found in classifications nominally primary but that include employment that produces for local demand.[8] For example, a high proportion of agricultural income comes from dairy products, poultry, truck, and livestock sold for local consumption. Certain lumber products are locally consumed, and it would doubtless be found that a considerable proportion of a state's manufacturing is for a trade area that is essentially local. Suppose, as a rough guess, we should say that one-half the employment in agriculture, in textiles and apparel, in lumber, and in furniture and miscellaneous wood products are engaged in producing for such a local trade area. If we take the median percentage employed in these industries as the typical state employment, this would add nearly 15 per cent to the 54 per cent and would indicate that typically about 70 per cent of the employment in a state would be of the passive type while about 30 per cent would be primary or active or "carrier"

[8] It should be remarked that in the cases of some states much of the employment in industrial classifications that are nominally passive is in fact dependent upon "external" demand. For example, certain of the sparsely populated mountain states, such as Nevada, Montana, Wyoming, and Utah, have a quite high proportion of their employment in transportation. This, presumably, is because of the trunk east-west transportation lines passing through these states. Also, the high proportion of employment in retail trade, amusements, finance and insurance, hotels, et cetera, in such places as New York and Massachusetts is in considerable measure dependent upon income changes external to these areas.

These classifications are ambiguous in another respect. Some industries, though bearing the same name in the various places, will in fact be parts of different industries, and an industry that is passive in some regions may be in another region an auxiliary of a primary industry. For example, a good portion of the utilities in Michigan is an auxiliary of the automobile industry.

in the sense that the demand for its products is external to the state.[9] Thus, were all states "typical" in this respect, the nature of the products of around one-third of the employment of a state would determine the sensitivity of that state to national cyclical forces.

With the above generalizations regarding industrial location in mind, we may approach our principal problem. Our questions now are: Do states fall systematically into groups of states showing significantly

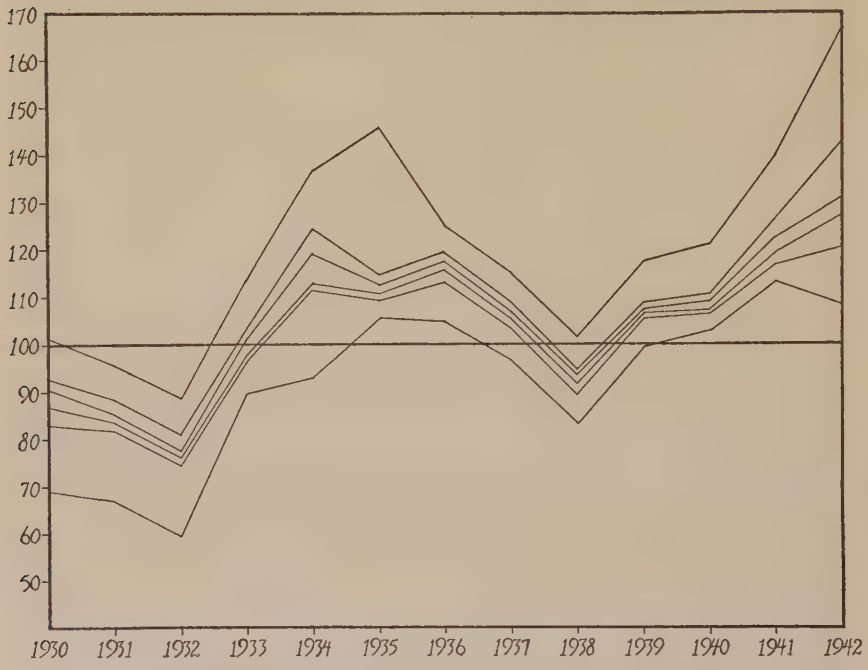


FIGURE 1.—Ranges of quintile intervals in the annual arrays of annual state income payments expressed as percentages of year previous.

[9] Florence estimates a smaller figure for the residentiary component of employment. "Calculations for the whole United States of the occupied presons that must locate close to the consumer, including construction and some manufacturing, show a proportion of 48% of the total of occupied persons. But for limited areas the necessary proportion is undoubtedly lower. . . . We may take 35% of all workers as a reasonable minimum for service workers. Adding 3% for building workers as a similar minimum, the minimum residentiary component of all workers appears as 38%." *Op. cit.*, p. 16. In this instance Florence is dealing with an area smaller than a state, and, of more importance, his problem is different from that with which we are concerned. He is attempting to anticipate the *minimum* number of service workers required for the establishment of a given primary industry. We are attempting to estimate the *typical* proportion of employment producing goods sold in the local market.

similar behavior with respect to rates of change of income? If so, do the primary industries of the states within a given group provide a rationale for this similar behavior?

3. REGIONAL PATTERNS OF CYCLICAL FLUCTUATIONS

This problem of classifying regions into groups showing internal uniformity of cyclical behavior is, so far as we know, a problem that has not been studied extensively.[10] It is a problem, however, that would seem to introduce interesting analogies with other fields of analysis. Just as in all problems of the analysis of variance, we have here a set of variates that may in principle be classified in accordance with certain attributes. On the basis of such classifications, the variation within groups of regions could be compared with the variation between the groups such that patterns of cyclical behavior may be discerned if they exist. The systems of classification then may yield additional insight into the process involved in the interregional diffusion of localized economic shock.

As a matter of fact, the method of study that we have adopted up to the present development of our inquiry is only analogous to an analysis of variance in a quite rough and backhanded manner. The data that we have now at hand would hardly justify an elaborate analysis, but a simpler method can at least suggest an outline of further inquiry. Table 2 and Figure 1 show by years the quintile intervals of state income payments expressed as percentages of the preceding year.[11] We have first endeavored to find out if the shifts among the occupants of these quintile intervals give evidence of a regional pattern of behavior as the different phases of the business cycle develop. These intervals represent segments of the horizontal scales of our frequency distributions of state percentage changes, and if the individual states appear to be distributed at random from year to year within these ranges then we may

[10] Without making a pretense of documenting the discussion of this problem of regional variation of economic fluctuations, we should at least like to call attention to two sets of stimulating articles in this field: the papers by D. G. Champernowne, "The Uneven Distribution of Unemployment in the United Kingdom, 1929–36," *Review of Economic Studies*, Vol. 5, February, 1938, pp. 93–106 and Vol. 6, February, 1939, pp. 111–124; and the articles by H. W. Singer, "The Process of Unemployment in the Depressed Areas (1935–1938)," *ibid.*, Vol. 6, June, 1939, pp. 177–188, and "Regional Labour Markets and the Process of Unemployment," *ibid.*, Vol. 7, October, 1939, pp. 42–58.

[11] The data used in the computation of these percentages are the same as those used in the analysis described in the cited article in the July, 1945, ECONOMETRICA. The estimates of state income payments for 1929 through 1939 are those published and discussed in the *Survey of Current Business*, Vol. 22, 1942, pp. 18–26; the data for 1940 through 1942 are from the June, 1943, issue, Vol. 23, pp. 10–22.

consider that the data evidences no such pattern as we have in mind. But if states from year to year move in groups within the frequency distribution, and if there is evidence of characteristic groupings within the different phases of the business cycle, then a pattern would be at hand that would provide a basis for further study. Our method of classifying the states was as follows: For each state the number of the quintile interval (lowest quintile designated as first, highest as fifth) that included the percentage figure for that state was listed for each year. States that year after year fell into the same or adjacent quintile intervals were grouped together. Because of the fact that only nine or ten states can occupy any given quintile interval and because of the very narrow limits of many of the quintile intervals, certain deviations from the apparent group pattern were ignored in grouping the states. The procedure was first to set apart certain states that appeared to the eye to conform most consistently to a pattern and then to set apart certain states whose patterns bear a strong family resemblance to that of the group except that occasional marked discrepancies occur. This procedure is merely a short and rough method of studying the matter of whether the variance indicated by the variation within groups is smaller than that indicated by the variations between groups. Should a group of states fall in the same quintile interval year after year, it would mean that one quintile interval is sufficient to include all the variation of this group of states.[12]

In Group I we include Arkansas, Mississippi, and Alabama, and it is clear that Tennessee and Georgia show strong family resemblances. With somewhat more discrepancies the remaining states of the Old South with the exception of Florida show a family resemblance. The quintile patterns for this group are shown in Table 3. Considering the relatively narrow ranges of the quintiles, these state figures show a remarkable conformance to a pattern. Among the first three states, it can be said that there are few significant discrepancies. In 1938, Mississippi in the second quintile interval appears relatively low compared to the other two states which are within 3 percentage points of each other in the upper part of the array. Yet Mississippi in this year is within 3

[12] The range of the component group compared with the range of the total tells us not much, of course, unless we have some conception of what we should expect it to be, assuming homogeneity of our variates. But from what is known about the relation between range and size of sample drawn from a normal population, the range exhibited by the 48 states should not be much more than 1.5 to 2 times the range within a component group composed of from 5 to 10 states. We make no effort at this time, however, to develop such a criterion.

A possible alternative simple method of classification might consist of computing for each year and for each state the deviations from the mean in terms of standard units and arranging these deviations into groups.

TABLE 3

QUINTILE PATTERNS OF THE STATES WITHIN GROUP I

Year	Ark.	Miss.	Ala.	Tenn.	Ga.	Ken.	La.	N.C.	S.C.
1930	1	1	1	1	1	1	2	1	1
1931	2	1	1	2	2	3	4	3	4
1932	5	5	4	4	5	3	4	5	5
1933	3	3	3	4	4	3	2	5	5
1934	4	5	5	5	5	3	4	4	5
1935	4	3	3	2	3	4	1	1	1
1936	5	5	5	4	2	4	3	1	4
1937	1	1	1	3	1	3	3	3	2
1938	5	2	3	3	4	2	5	4	4
1939	3	5	2	4	2	3	2	4	5
1940	1	1	4	4	4	2	1	1	5
1941	5	5	5	5	4	2	3	4	3
1942	5	5	4	2	4	3	3	4	4

points of Alabama. In the following year, 1939, while Arkansas and Alabama are within 1 percentage point of each other, Mississippi is about 5 points above these other two. In 1940, Arkansas and Mississippi stay together, but Alabama is about 6 points above the others. The rest of the states show discrepancies from time to time, yet all are clearly pulled toward the same general vicinity within the array, and in the cases of most of the discrepancies reference to the percentage figures will show a close similarity. In 1931, the declines registered by the first three states were somewhat more marked than in the rest of the group. In 1933, North and South Carolina were completely out of line showing rises of some 12 per cent while the others of the group were showing practically no change in income. The discrepancies in 1935 are not so

TABLE 4

QUINTILE PATTERNS OF THE STATES WITHIN GROUP II

Year	N.Y.	Mass.	R.I.	N.J.	Vt.	N.H.	Me.	Md.	Mo.
1930	4	4	4	5	3	4	5	5	3
1931	4	5	5	4	4	5	5	5	3
1932	3	5	4	4	3	3	4	4	3
1933	1	1	1	1	1	3	3	2	2
1934	1	1	1	1	1	2	1	2	1
1935	1	1	1	1	2	1	2	1	3
1936	1	1	1	2	2	1	1	2	2
1937	2	2	2	3	1	2	1	4	2
1938	3	3	2	3	2	4	3	4	3
1939	2	2	4	4	4	1	3	3	3
1940	2	2	2	4	2	1	2	5	1
1941	1	2	4	2	1	1	3	4	4
1942	1	1	1	2	1	1	2	3	2

great as the quintile figures would suggest, a range of 5 per cent being sufficient to include all the states of the group. In 1936, the first three states of the group showed somewhat larger gains than the others. In 1940, certain of the group got out of line, Mississippi accounting for the extreme low of the entire array of states and South Carolina being almost the extreme high. But even here, a range of 10 per cent would include all the states and a range of less than 5 per cent would include all except the extremes. With these qualifications, it can be said that this group of states follows in general the same pattern of behavior.

In Group II are placed New York, Massachusetts, Rhode Island, and New Jersey, and a strong family resemblance is in evidence in the cases of Maine, New Hampshire, and Vermont. The pattern of Maryland in some respects resembles the pattern of this group, but it also appears to relate itself with the pattern of another group that will be described later. Missouri we are tentatively placing with this group, although the basis for this classification is somewhat slight. The pattern for this group is shown in Table 4.

Here, too, the conformance to a pattern appears to be quite evident. In the case of the first four states there is no significant divergence from the general pattern. In 1932 New York was in the third quintile interval while Massachusetts was in the fifth, but New York was in the high part of the third while Massachusetts was in the low part of the fifth. While the range of the rates of change for all states in this year was 28 per cent, approximately 3 per cent was the difference between the rates of decline of these two states. In 1939, divergencies were apparent. But they seem to be unimportant, the rate of increase of New York and Massachusetts in the second quintile interval differing by less than 3 percentage points from that of Rhode Island and New Jersey in the fourth. In 1940, New Jersey is about 4 points above the other three states, and in 1941 Rhode Island appears to have received a greater impetus than the other states.

Maine, New Hampshire, and Vermont show only slight discrepancies from the group pattern. Reference to the percentage figures for these states indicates a rather close conformance with the group pattern throughout the years.

The pattern of Maryland conforms roughly with that of this group, but it shows evidence of being pulled in the direction of the pattern of the group to be next described, especially for the latter five years.

Missouri's is a more tenuous classification. When the percentage figures for this state are placed along side of those of the other states of this group, the conformance is very close. But for reasons that will be presented at a later point in our discussion it appears likely that the grouping will follow geographical lines when such large areas as states

are regarded as the "regions." When the behavior of more appropriately defined "regions" is analyzed there is evidence that the satisfaction of certain conditions will result in groupings that follow industrial lines with less regard for geographical contiguity. In the case of Missouri the conformance to this pattern should perhaps be explained on special grounds, and these grounds will be presented when the attempt is made to rationalize the group patterns.

In Group III we place Indiana, Ohio, Michigan, Illinois, and Pennsylvania. Connecticut and Delaware bear a strong family resemblance. West Virginia and Wisconsin show resemblances, but marked discrepancies are in evidence. The quintile patterns for this group are shown in Table 5.

TABLE 5

QUINTILE PATTERNS OF THE STATES WITHIN GROUP III

Year	Ind.	Ohio	Ill.	Mich.	Pa.	Conn.	Del.	W.Va.	Wis.
1930	2	2	2	2	3	4	2	2	2
1931	2	2	2	2	3	4	5	4	2
1932	1	1	1	2	2	3	3	3	2
1933	3	3	1	1	2	2	2	4	3
1934	3	3	3	5	3	2	3	4	3
1935	4	3	3	5	1	2	2	1	5
1936	4	4	3	4	3	3	4	4	3
1937	5	4	5	5	3	4	4	3	3
1938	1	1	1	1	1	1	1	2	2
1939	5	5	5	5	3	4	5	1	1
1940	3	3	3	5	3	4	5	3	3
1941	5	4	2	4	2	4	1	2	3
1942	2	2	1	2	1	2	1	2	2

A general pattern is in clear evidence in the cases of the first five states. The pattern of Pennsylvania, however, appears to be drawn to some extent in the direction of that of Group II. In 1930, the tendency was for Group II states to be in the upper quintile interval and for Group III states to be in the second. But Pennsylvania was the upper extreme state of the third quintile interval. In 1935, it occupied a Group II position, and from 1939 on it conformed with the pattern of Group II.

Michigan shows several marked discrepancies and is obviously the more volatile of this volatile group. In six of the thirteen years, it was within four states of one of the extreme ends of the array. In 1933, its rate of decline was greater than the other declines of the group, and in 1934, its rate of rise was considerably greater. After 1939 the rises registered by Michigan were considerably greater than those of the other states of the group.

These other states of the group are not so far out of line with one another in 1933 as the quintile locations would suggest. The range of variation for all 48 states was 24 percentage points, while the range of variation for Group III states excepting Michigan was 5 per cent.

Reference to the percentage figures for the first five states indicates few other discrepancies of importance. Illinois was low in 1934, and Illinois and Pennsylvania were somewhat low in 1941. But it can be

TABLE 6

QUINTILE PATTERNS OF THE STATES WITHIN GROUP IV

Year	Wash.	Ore.	Calif.
1930	3	2	5
1931	2	3	3
1932	2	2	3
1933	4	3	3
1934	3	4	3
1935	2	4	2
1936	5	5	5
1937	2	2	3
1938	4	4	4
1939	2	4	2
1940	4	3	4
1941	5	4	3
1942	5	4	3

said, subject to the qualifications regarding Michigan in 1933 and regarding the apparent relationship between Pennsylvania and Group II, that the five states adhere very closely to a group pattern and occupy the same vicinity of the frequency distribution year after year.

The other states show certain divergencies. Connecticut occupied a Group II position during about the first half of the period. Since 1937, it has conformed closely with the pattern of Group III. Delaware also is attracted to the Group II pattern. West Virginia shows marked discrepancies, but its percentage pattern closely resembles that of Pennsylvania. Wisconsin shows a moderate resemblance, but its position, like Missouri's, tends to remain in the center of the array or toward the lower end of the array of the absolute rates of change.

In Group IV are the Pacific Coast states—Washington, Oregon, and California. The adherence to a group pattern is somewhat closer than the quintile interval shown in Table 6 would suggest. Until 1941, a range of 8 points would include all three states in any year, and excepting 1930 and 1934 a range of 4 points would suffice. In 1941 and 1942 Washington and Oregon gained at a more rapid rate than did California. The tendency for this group appears to have been for relative stability, the position in the array tending to be the middle ground. The

exceptions are 1936 and the two war years when the group occupied the upper reaches of the arrays.

In Group V are placed certain political divisions that have shown a marked tendency for expansion. The percentage figures when placed alongside of each other do not give as clear an impression of consistency as do the quintile figures, but even here the conformance to a pattern is in evidence. In seven of the years a range of 5 percentage points includes all the states, in three more years a range of 8 points will suffice, and in the remaining three years 14 points separate the lowest from the highest percentage of the three. Obviously, expansionary forces of an unusual character have been in operation in these three areas. It does not follow, of course, that the similarity in the reactions

TABLE 7

QUINTILE PATTERNS OF THE STATES WITHIN GROUP V

Year	Dist. of Colum.	Va.	Fla.
1930	5	3	4
1931	5	5	4
1932	5	5	4
1933	1	2	2
1934	2	4	4
1935	4	2	4
1936	5	3	5
1937	2	2	4
1938	5	5	5
1939	1	4	5
1940	3	5	4
1941	2	5	2
1942	3	3	3

of these areas is due to the similarity in economic structure. Noncyclical factors were doubtless playing a most important role. In nine of these thirteen years these areas were well into the right tail of the frequency distribution. Virginia did not show this tendency to expand so much as did Florida, and the District of Columbia was somewhat more erratic. Milder contractions and stronger expansions were shown by these three areas than was generally the case.

Groups I, II, and III represent to us a fairly satisfactory classification of cyclical reaction patterns and are tentatively satisfying in the sense that certain statistical regularities are suggested for which an accounting is called. More interesting classification may be made, we think, when more appropriately defined regions are used in the analysis, but nevertheless the state groupings raise certain pertinent questions. Group IV is not quite so satisfactory and Group V is somewhat less so, for we feel that what similarity is suggested may be largely

TABLE 8

QUINTILE PATTERNS OF THE STATES WITHIN GROUP VI

Year	*a*							*b*				*c*				
	Okla.	Tex.	Ariz.	Utah	N.M.	Colo.	Idaho	Mont.	N.D.	Nev.	Wyo.	Neb.	Iowa	S.D.	Kan.	Minn.
1930	1	2	2	3	3	4	3	1	2	5	4	5	5	5	5	4
1931	1	2	2	2	4	3	1	1	1	5	3	1	1	1	2	3
1932	3	4	1	1	2	3	2	1	3	4	1	1	1	1	1	2
1933	5	5	4	4	5	4	5	4	5	1	5	5	5	4	4	3
1934	1	3	4	3	4	2	5	5	1	4	4	1	1	5	3	2
1935	4	3	3	5	4	3	3	5	5	5	2	5	5	5	4	5
1936	2	3	4	3	5	4	5	1	1	2	2	1	1	1	2	3
1937	5	5	5	5	4	5	5	3	5	4	1	1	5	1	4	3
1938	3	5	2	4	3	2	2	2	1	1	5	2	5	5	1	4
1939	1	1	2	1	4	2	1	3	4	5	3	1	5	3	1	2
1940	1	1	1	5	3	1	3	5	5	5	2	3	1	2	4	1
1941	1	4	3	3	1	1	3	2	5	1	2	1	4	4	5	1
1942	4	4	5	5	3	3	4	1	3	5	2	5	3	4	5	2

attributable to noncyclical forces. But the rest of the states—those of the Great Plains and Rocky Mountain regions—give even less satisfactory results. The methods that we are using did not reveal consistent breakdowns into groups showing internal uniformity regarding rates of change of income. Several types of factors could be responsible for this lack of evidence of group behavior among these states. In the first place, the data have obvious shortcomings from which might be expected considerable statistical error. The bulk of the very sparsely populated states is included in the present group. Of these sixteen states nine are smaller economically than either Arkansas, Mississippi, or Rhode Island. Any one of these nine accounts for smaller income payments than either of these latter three states. These nine states—North and South Dakota and the Mountain States excepting Colorado—together account for only about $2\frac{1}{2}$ or 3 per cent of the national income payments, which is less than the income payments of Texas and about the same as those of Missouri. The estimates that are available are rounded to the nearest million, and this mere rounding could result in an "error" of from 1 to 2 per cent in the cases of the smaller states—that is, the number of digits in our computed percentage changes is more than is warranted by the data. Of more importance perhaps are the errors of statistical estimate. Revisions of these figures frequently involve changes of substantial amounts, and in the cases of the smaller states the effect upon the percentage changes may be quite marked.[13] But aside from the shortcomings of the data,[14] there are "real" factors that may underlie the lack of uniformity displayed by these state figures during this period. Within this decade under review, certain "non-economic" forces of great importance affected the incomes of the Great Plains states without regard to economic structure. The unprecedented drouths in this region and the influence of governmental intervention

[13] Regarding the revisions of these estimates of state income payments, it may be in point to call attention to what was stated in footnote 15, page 201 and 203 of the article previously cited in ECONOMETRICA, Vol. 13, July, 1945. The same analysis described in the present paper was first applied to figures published in the *Survey of Current Business* for October, 1940. Although the revisions appearing in the July, 1942, *Survey* were considerable, even involving a change in definition, the two sets of data yielded the same conclusions regarding the cyclical behavior of rates of change.

[14] We are aware of the arbitrariness and the question-begging character of an argument that accepts any support that a set of data may provide for a hypothesis but explains lack of support in terms of the shortcomings of these data. For all that we may say, the *support* that the data provide may be attributable to the "shortcomings" of the data. This amounts to saying that at this stage of the inquiry and with the data that are available statistical results must be regarded as steppingstones for intuition, and a priori reasoning must be the guide in the tentative inferences drawn from the data.

could have affected these percentage changes sufficiently to confuse the quintile interval patterns.

The above factors mentioned are such as would muddy up the statistics in such a way that a pattern that might actually exist would not be revealed. There are other considerations that would possibly support doubts as to the existence of a consistent pattern of cyclical reactions of these *state* figures. In previous paragraphs we spoke of a state as containing parts or the wholes of several economic regions and of a state's cyclical reaction pattern as being merely an average of the respective patterns of the component regions. Where a state is populous and industrially diversified, there would be a relatively large "sample" of regions represented by the state figures, and the quintile position of the state would not likely be affected by erratic movements of single industries or regions. Or where the regions of a state or a group of states are all specialists in the same single "carrier" or "export" industry, a consistent pattern of behavior may exist even though the pattern itself shows erratic movements in time. But where states are sparsely populated so that state figures represent an average of a small number of regions, and where these component regions of a state show wide economic diversity, then erratic behavior of a single industry or region may each year determine the quintile position of a state, and state figures may reveal no group pattern.

However, for the sake of completeness these sixteen states are placed in Group VI with three subclassifications. Table 8 shows the positions of the respective states in the annual frequency distributions. In the year 1933 the entire group showed uniform reaction. These states practically occupied the top 40 per cent of the frequency distribution. In 1930, 1931, 1933, 1935, 1937, 1939, 1940, and 1942 Group VI*a* showed uniformity. Disregarding extremes, we may say that Group VI*b* showed uniform reaction from 1933 through 1936 and again in 1939 and 1940. The patterns within Group VI*c* were similar from 1930 through 1933 and again in 1935, 1936, and 1942. Borderline states appear to be pulled in the direction of adjacent groups. Thus, Oklahoma and Texas appear to be pulled in the direction of Group I. The patterns of Louisiana and Texas are quite similar. Minnesota is pulled in the direction of Group III, and Wyoming in the direction of Group IV. In at least one case geographical continuity is broken, Nevada having a pattern very similar to that of Connecticut. The states directly west of Texas appear to be pulled in the direction of the Mountain states farther north, and these in turn are pulled in the direction of the northern Great Plains states.

Considering the patterns of the six groups, then, it appears to be true that when areas as large as states are studied certain geographical patterns of business-cycle response may be observed. Groups of contiguous

states respond similarly in the business cycle, and the patterns of the border states of these groups appear to be "pulled" in the direction of the neighboring group. Certain groups of states typically show more violent changes than do other groups. A business expansion or contraction works out over the entire national area, but *rates* of expansion or contraction differ in a typical manner as between areas.

The states of Group VI are among those whose income payments fluctuate relatively greatly. The figures for the rates of change for Oklahoma, Nebraska, Iowa, South Dakota, North Dakota, Montana, Idaho, and Nevada were located in the extreme quintile intervals more than two-thirds of the time. It is rare that these states are found in the middle quintile intervals of the frequency distributions. This tendency to fall in one of the tails of the distribution is also true of Group I states. In the patterns of Arkansas, Mississippi, and Alabama, the extreme quintile intervals appear about two-thirds of the time. One is tempted to generalize that such states show more rapid rises in years of rising income and more rapid declines in years of falling income. Many exceptions appear in the data analyzed—too many, one may feel, for the data to be regarded as supporting the generalization. In working with the data, however, a strong impression is gotten that the exceptions may be largely attributable to differences in the timing of the turning points and that an analysis of quarterly data will be much more revealing, particularly for these periods in the vicinity of the cyclical turning points.

The converse of the above generalization may be stated with some confidence regarding the behavior of Group II states. These states are also found in the extreme quintile intervals, but they are in the high quintile intervals when income is falling and in the low quintile intervals when income is rising. Had rates of change been arrayed without regard to sign, these states would have been, in general, the occupants of the lower reaches of the array. There is one apparent exception. In 1933 these states were among those showing the greater declines. But this year would be a case in point for the observation made above with regard to the inadequacy of annual data in the analysis of the turning-point periods. In an important sense, 1933 could be considered as a year of income rise, the bulk of the forty-eight states showing either income rises or else no appreciable changes in income, and the more volatile raw-material-producing states showing quite substantial gains. When rates of change are arrayed, the Group II states (excepting Missouri) are found in the lowest quintile interval forty-four times. Were each of the forty-eight states equally likely to fall in this interval, we should expect to find Group II states there twenty-one times during the period.

We are not in a position to formulate with confidence a generalization regarding the timing of business change as between different re-

gions. At one time there was a fairly prevalent notion that a westward lag of business fluctuations exists in the United States—declines or recoveries in business being first noticeable in the East, then in the Middle West, finally in the Pacific Northwest. As more data have been made available, this view has not been substantiated,[15] although the fact that current data, reflecting the behavior of the economic structure that now prevails, does not indicate such a lag is not evidence against the view that such a pattern did exist when the economic structure of the country was different. If employment in certain regions were concentrated in industries producing for inventory demand, for durable-consumer-goods demand, and for plant and equipment demand, then these regions would be likely to be affected somewhat earlier in a recovery or decline. But it seems clear that the location of industry is not suggestive of a situation that would give this westward lag to business fluctuations. As a matter of fact, our impression, as pointed out above, is that further study will substantiate the hypothesis that the raw-materials-producing areas, the demand for whose "export" products is so subject to "inventory" decisions, will typically show the initial developments of cyclical change.[16] But whatever may be said now regarding the timing of the turning points, there is clear evidence of typical differences in the degree to which regions are affected by the business cycle.

The final point to be raised in the present paper involves the question of the extent to which our observations on the regional nature of industrial location may throw light upon the factors that would determine the sensitivity of a given region to the cyclical forces operating within a larger area.

4. FACTORS UNDERLYING REGIONAL VARIATION IN TIMING AND AMPLITUDE OF CYCLICAL FLUCTUATION

In Section 2 a procedure of Sargant Florence was adapted, and the various industries of a region were classified into "residentiary" or "passive" industries on the one hand and "primary" or "carrier" in-

[15] Joseph Demmery and Fred Ritchie, "The Westward Lag in Business," *Journal of Business*, Vol. 7, April, 1934, pp. 173–181.

[16] Cf. pp. 207–208 of the article cited in ECONOMETRICA, July, 1945. If space permitted it would perhaps be of interest to compare certain tentative conclusions reached from a study of international data in Sir William Beveridge's *Full Employment in a Free Society*, New York, 1945, with the present conclusions inferred from the behavior of regional series representing the business behavior for the component parts of a single national area. Reference is had here particularly to Appendix A, paragraphs 33, 35–42. There are suggestions of these conclusions, it may be recalled, in Keynes's brief discussion of the role of agricultural and mineral production in the business cycle, *The General Theory of Employment, Interest and Money*, New York, 1936, pp. 329–331.

dustries on the other, the character of the latter type determining a region's responsiveness to business-cycle forces. We indicated there the basis for our rough estimate that typically about two-thirds of a region's employment produces for local consumption, this portion of the employment thus being passive in the interregional propagation of economic shock, and that about one-third depends upon external demand, being consequently the active carrier in the transmission of business perturbations. Let us now give a sketch, rough though it is, of the character of the employment of our different groups of states. For the present purpose let us simply record certain observations regarding the states that form the more consistent patterns. In Group I these states are Arkansas, Alabama, and Mississippi. In Group II, New York, New Jersey, Massachusetts, and Rhode Island are the states more consistently moving together. In Group III, these states are Illinois, Ohio, Indiana, Michigan, and Pennsylvania. Certain states of Group VI, while not forming a consistent pattern, fall fairly regularly in the tails of the frequency distributions, and in this respect they share a characteristic of the Group I states. These states are Oklahoma, Iowa, Nebraska, South Dakota, Montana, North Dakota, Idaho, and Nevada. Finally, Missouri is of some interest because of its conformance with the pattern of the Group II states.

From the various census reports of 1940—*Occupations*, *Agriculture*, and *Manufactures*—the following inferences may be drawn: Arkansas and Mississippi are highly specialized in agriculture, and that agriculture is in turn highly concentrated in cotton production. Typically, cotton accounts for more than half of the total farm income, and more than half of the employed population is engaged in agriculture. Alabama is also a heavy cotton specialist, nearly half of the farm income being derived from cotton production. In the case of Arkansas and Mississippi, cotton and lumber production constitute the bulk of the "primary" or "carrier" employment, although, of course, certain parts of these states depend upon other industries for "exchange" on the "outside" economy. In Alabama, where agriculture is not quite so important, two other industries are added. In coal mining and iron and steel manufacturing together there are approximately 6 per cent of Alabama's employment. In the textile industry there is an additional 6 per cent. These two industries, along with cotton and lumber, appear to relate Alabama's business fluctuations to "external" regions. It would seem that in the case of these three states, the "carrier" industries consist of a few industries, each producing products having high income elasticities. This condition provides an easy rationale for the violent fluctuations of income in these states, and the general similarity of the main carrier industries is in conformance with the uniformity of the rates of business change in these states.

In the case of the Group II states the carrier or primary industries seem to be mainly among the processors of durable and semidurable consumer goods. Agriculture is of insignificant importance in the four states under review, there being only 3 or 4 per cent of the employment engaged in agriculture and that in dairying and truck farming for local consumption. Textiles and apparel is the largest single carrier industry employing 8 per cent in New York and 23 per cent in Rhode Island. The other employment relating these states to "external" regions is well diversified. If for each industry there were arrayed the state figures for percentage of total employment found in that industry, these states would be found in the high quintile intervals in practically all the manufacturing industries. In order to account for the 25 to 35 per cent of employment that is estimated to be engaged in producing for external markets, at least seven or eight broad industrial classifications would have to be included. Even in such industries as would ordinarily be regarded as primary industries, local markets in the cases of these states must take a high proportion of such production. Thus, it would seem that these populous areas are economically relatively diversified and self-sufficing, and produce externally marketed products having income elasticities that are low relative to the elasticities characterizing the agricultural and mineral raw materials. All of this means a milder business fluctuation. The agriculture, lumber, paper, shoes, and textiles of Maine, New Hampshire, and Vermont depend presumably upon the markets of the metropolitan areas of this region, and thus the economies of these states are tied to the patterns of these more populous areas even though the economic structures of these smaller states bear little resemblance to the other states of the group. In Connecticut, some 20 per cent of the employment is in those industries characterizing the industry of the states of Group III, and as a consequence, it would seem, the pattern of this state appears to be a combination of Group II and Group III.

Missouri's pattern, it has been noted, is very similar to that of Group II even though great distances separate these areas. There is little basis, however, for attributing this similarity to a similarity of economic structure. Even though the economic structures were identical, it would be extremely unlikely that uniformity of cyclical behavior would be maintained when the states are geographically so far apart. It has been indicated that the "passiveness" or "localness" of a given industry is a matter that depends in some considerable degree upon the definition of the region. The market areas of many of a state's residentiary or passive industries will reach out into contiguous states so that ordinarily the experience of surrounding regions will have its effect upon a given state regardless of the main outlines of its economic structure. In the cases

of economically small, highly specialized states or of smaller regions specializing in one or a few products marketed in central markets, this relationship with surrounding areas may not be important; but for areas as large and as diversified as the larger states, geographical contiguity seems practically essential for consistent pattern behavior. The uniformity of behavior in the present case may be explained on other grounds. It will be noticed that the patterns of the Group II states show relatively small rates of increase in years of expansion and relatively small rates of decline in years of contraction. The quintile pattern of any state showing this same relative stability would conform in general to that of the Group II states. It will be found that Missouri's economy is perhaps as diversified as that of any state in the country. The percentages in the different employments conform quite closely to the national percentages—indicating, that is, a self-sufficiency and diversification that would be found in few other states.[17] No one or several industries dominates the economy. Its farming is diversified, and if there is any manufacturing specialty this specialization is in food processing and shoe manufacturing. This self-sufficiency and diversification would indicate a relative stability that would render the pattern similar to those of the Group II states.

The Group III states—Indiana, Ohio, Michigan, Illinois, and Pennsylvania—are dominated by the heavy industries. In these states, the metal-products industries, machinery production, automobile production, and the auxiliary industries such as coal mining, account for from 15 per cent to 25 per cent of the total employment. The urban areas of this region depend to a considerable extent upon these few types of industry, and the farming areas produce in the main corn and hogs and dairy products, the latter for local metropolitan consumption. In general, these stages show more violent changes than do the Group II states, and the specialization in durable manufactures for investment demand would be in accordance with this greater amplitude of short-run business change.

The states belonging to Group VI that we are discussing—Oklahoma, Iowa, Nebraska, South Dakota, Montana, North Dakota, Idaho, and Nevada—are of interest at this time by virtue of their fairly regular appearance during this thirteen-year period in the extreme tails of the frequency distributions. Special and random circumstances could doubtless account for much of this extreme behavior, particularly in the case of the Great Plains agricultural states. But it should be noted that all

[17] Sargant Florence concluded that Missouri was the most economically diversified of all the states. Cf. his "The Measurement of Economic Balance and Diversification," Mimeographed release of the National Resources Planning Board, 1940.

these states are highly specialized in producing raw materials. Oklahoma is dominated by cotton and petroleum production and refining. Iowa is predominantly agricultural and specializes in corn and livestock. Nebraska's concentration is in corn, livestock, and wheat. South Dakota is as predominantly agricultural as Arkansas and Mississippi, depending, however, upon wheat, corn, and livestock. Montana and North Dakota are dependent upon wheat and livestock. Montana, in addition, has nearly 10 per cent of total employment in mining and metal refining, the principal mineral involved being copper. Idaho is dominated by livestock agriculture, nonferrous metals mining, and lumber. Nevada is principally a mining state, 15 per cent of its employment being engaged in the mining of nonferrous metals. Mining employs as many people as does agriculture in Nevada, and what agriculture there is, is mainly range livestock.

Thus, these states, like the Group I states, are specialists in agricultural and the other extractive industries. A relatively high proportion of the employment of these states is dependent upon external demand, and this latter would appear to have a high short-run income elasticity. The situation of these raw-material-producing states would seem to be something like that of the marginal facilities of a manufacturing firm. For much of their production, demands are only forthcoming at high levels of national income and high levels of national investment activity. When investment activity slackens, the use of the raw-materials output of these mountain, plains, and southeast states declines drastically. This decline in the primary industries is then transmitted to those residentiary industries producing for local demand.

Two observations of Keynes in his *General Theory* are of especial pertinence regarding the rather exceptional violence of cyclical fluctuation in these areas in which the primary industries are predominantly agricultural and mineral. Keynes raises, in order to explain away, an apparent paradox. He says:

> We have seen above that the greater the marginal propensity to consume, the greater the multiplier, and hence the greater the disturbance to employment corresponding to a given change in investment. This might seem to lead to the paradoxical conclusion that a poor community in which saving is a very small proportion of income will be more subject to violent fluctuations than a wealthy community where saving is a larger proportion of income and the multiplier consequently smaller.

He then dissolves the paradox and concludes that

> whilst the multiplier is larger in a poor community, the effect on employment of fluctuations in investment will be much greater in a wealthy community, assuming that in the latter current investment represents a much larger proportion of current output.

He indicates symbolically his conclusions, setting up an expression representing the relative change in income for a given relative change in investment,

$$\frac{dY/Y}{dI/I} = \frac{1 - C/Y}{1 - dC/dY}.$$

"As wealth increases dC/dY diminishes, but C/Y also diminishes."[18]

Now as a matter of fact, his original paradox substantially describes the facts so far as the regions within this country are concerned. The poorer regions within the nation make up the bulk of the areas exhibiting the more violent cyclical fluctuations. The reason for this, however, is not hard to find. These less wealthy areas happen to be those great "colonial" stretches that yield up the extractive raw materials that are processed in the manufacturing areas. They are also highly specialized in their production so that imports and exports represent relatively high proportions of total income. If the average and marginal propensities are defined as in the literature on the "foreign trade multiplier"[19]—that is, as propensities to consume local products—and if the states of this nation were arrayed in accordance with wealth or per capita income, then we should undoubtedly find as wealth increases that dC/dY will diminish but that C/Y will increase. That is, the above ratio of the proportional change in income to a proportional change in investment would be lessened as we move along the array from the poor to the wealthy areas. dC/dY would diminish because imports would be relatively insensitive to changes in income in the highly specialized raw-material-producing areas and relatively sensitive to changes in income in the manufacturing Northeast. The increase of C/Y would reflect the increased proportion of employment in the wealthier areas that produces for "local" consumption. This perverse result, of course, would not represent a functional relationship between wealth and these propensities. Rather, it would be due to the negative correlation, in this case, between economic self-sufficiency and wealth and to the nature of the economic specializations involved.

The other observation of Keynes that may be noted here in connection with the observable regional differences in cyclical fluctuations has to do with his brief discussion of the role of agriculture in the business cycle.[20] He interprets a change in the carry-over of agricultural products as a change in the current rate of investment and points out that in

[18] *The General Theory of Employment, Interest and Money*, New York, 1936, pp. 125–126.

[19] Gottfried Haberler, *Prosperity and Depression*, 3rd ed. rev., Geneva, League of Nations, 1941, pp. 461–473.

[20] Keynes, *op. cit.*, pp. 329–332.

a community where agriculture is the predominant industry such changes in carry-over will be of overwhelming importance compared with any other usual cause of investment fluctuations. Groups II and VI are made up of such communities, but the effects that are described by Keynes would be even more intensified for these states. A predominant part of the value of their entire agricultural output would represent "investment expenditures" for them (in the sense adopted in discussions of the international trade multiplier), and carry-over changes would be accompanied by price changes. Keynes goes on to suggest that in the past perhaps no cause of investment fluctuation, except war,

> was in any way comparable in magnitude with changes in the carry-over of agricultural products. Even today it is important to pay close attention to the part played by changes in the stocks of raw materials, both agricultural and mineral, in the determination of the rate of current investment. I should attribute the slow rate of recovery from a slump, after the turning-point has been reached, mainly to the deflationary effect of the reduction of redundant stocks to a normal level. . . . Sometimes, indeed, the reduction of stocks may have to be virtually completed before any measurable degree of recovery can be detected.

It is common understanding now that a reduction in total consumer demand does not have to take place in the latter phase of an upward business movement in order that there should develop a reduction in demand for output subject to inventory decision. All that is required is the completion of the building up of previously depleted inventories so that the demand for output is lowered to the neighborhood of consumer taking. Or again, it is not necessary that consumer demand, that is, national income, rise in the latter phase of a downward movement in order that the demand for agricultural and other durable raw material output should rise. It is only necessary that that portion of consumption that has been provided from a disinvestment in inventories or carry-over be reduced sufficiently. A development of these considerations must surely lead to an expectation of relatively erratic and violent fluctuations and of an initial development of turning points within the Group I and Group VI states. In fact, the worst of an assortment of worlds, so far as the business cycle is concerned, seems to be the lot of these areas: a low average propensity to consume home products (that is, a high degree of specialization and dependence upon interregional trade); a high marginal propensity to consume home products (that is, a low income elasticity of demand for imports); a highly sensitive and relatively violent fluctuating multiplicand (that is, a high income elasticity of demand for the export products).

University of Virginia

Reprinted from
ECONOMETRICA, Journal of the Econometric Society, Vol. 14, No. 3, July, 1946
The University of Chicago, Chicago 37, Illinois, U.S.A.

THE REGION AS A CONCEPT IN BUSINESS-CYCLE ANALYSIS

BY RUTLEDGE VINING

In his great work on business cycles, Professor Schumpeter finds frequent occasion to observe that a study of business aggregates and totals has little likelihood of revealing the fundamentals of economic evolution. A point is raised in one phase of his work that has an especial bearing upon the aspect of short-run economic change that we are exploring. He is discussing the economic evolutions associated with "innovations" that have initiated a business expansion. There will be "old" firms—firms taking no part in the development of the innovations—that are adversely affected; but the first effects, he notes, even in these cases of directly affected firms that show the net losses, are softened by the flow of new expenditures incident to the new plant and equipment construction. But as the "gestation" period passes and as the new flow of commodities begins to appear upon the market, processes of adaptation begin to show. For some of the old firms

> . . . the new methods mean economic death; for still others, contraction and drifting into the background. Finally, there are firms and industries which are forced to undergo a difficult and painful process of modernization, rationalization and reconstruction. It should be observed that these vital parts of the mechanism of economic evolution, which are readily seen to dominate many business situations and to produce results of fundamental importance, can never be revealed statistically by measuring variation in an index of production, or analyzed theoretically in terms of total output. Such an index would display nothing except increase. But mere increase in total output would not produce those effects. It is disharmonious or one-sided increase and shifts *within* the aggregative quantity which matter. Aggregative analysis . . . not only does not tell the whole tale but necessarily obliterates the main . . . point of the tale.[1]

Likewise, he remarks, the study of the mechanism of the downward spiral affords a good example of how the macrodynamic approach may mislead.

> Price levels, totals of deposits and expenditure, net losses, and so on becoming the variables to be handled, the whole economic system in depression acquires the features of a losing concern whereas it is the essence of the process that the individual elements of those aggregates are differently affected.[2]

Anyone familiar with the adaptations that take place in every business expansion can provide illustrations of firms and industries that not only show losses in a period of general expansion but that show losses by virtue of the very factors responsible for the expansion. To this list

[1] Joseph A. Schumpeter, *Business Cycles*, New York, McGraw-Hill Book Company, Inc., 1939, Vol. I, p. 134.
[2] *Ibid.*, p. 153, note 1.

of firms showing a curtailment of operation would be added, as the movement develops, those firms completing their parts of the particular expansion in process and those that are forced to curtail operations because of an inability to obtain resources at prices consistent with their operations. The period of war production gave striking instances of these types of situations, but they are situations that are common in lesser degree in every expansion. H. W. Singer's analysis of the unemployment registers of Great Britain provides a suggestive picture that undoubtedly portrays a feature of economic change in general.[3] In good times and bad, there is a continuance of additions to unemployment registers, and in good times and bad there is a continuous absorption into employment from these registers. The turning points in the unemployment series come from the rate of absorption overtaking or being overtaken by the rate of addition. Singer's analysis of these two rates—their respective variations with respect to the different phases of the cycle and with respect to space at given points of time—shows an aspect of the dynamics of economic change that is quite effectively bundled up and hidden within the aggregates that are more commonly used in analyses of economic change. Working with something that at least may be imagined as the economic "units" or "particles," one gets a conception of what appears to the eye to be random economic "motion" that gives a meaning to "statistical" economics somewhat different from what the term ordinarily brings to mind—a meaning more in keeping with usage in modern physics. The "wave" that is observed in national averages and sums appears as something different if not entirely apart from the movements exhibited by the underlying economic "particles" or units. The motion of numbers of these units is always counter to the direction of the national "wave," and a national "turning point" appears as merely a shift in the direction of movement of the preponderance of the "particles." It is not a simple shift in direction of movement that characterizes what we think of as a turning point. Shifts in the direction of movement of individual particles are going on continually throughout all phases of the "national wave." The turning point occurs when a particular direction of movement ceases to be "counter" and assumes its role of ascendancy. Aggregative analysis does not show these adjustment processes of economic evolution that are so emphasized by Professor Schumpeter, and our problem is to devise a means by which a more complete observation may be obtained. Our contemplated approach involves, first, the definition of an appropriate spatial unit that may be regarded as a fundamental economic organism. In order to obtain a more detailed view of the

[3] "Regional Labour Markets and the Process of Unemployment," *Review of Economic Studies*, Vol. 7, October, 1939, pp. 42–58.

underlying adaptations of economic change, we intend later to analyze the interrelating behavior in time of such spatial units.

1. TENTATIVE RESULTS FROM EARLIER WORKS

Let us briefly review the tentative results reached in earlier papers.[4]

In the first place, we have argued that a figure representing the rate of economic change taking place in a national area such as the United States may be regarded as a parameter of a frequency distribution of rates of change in the component parts of this area. These component parts are members of a "universe," all sharing certain attributes relevant for the problem in hand, and all being acted upon in some degree by the same complex of forces in process in the nation. When states were tentatively accepted as the parts, a suggestion was found of an approximately logarithmic normal distribution of the regional rates of change,[5] the direction of skew and the magnitude of the dispersion of which being dependent, respectively, upon the phase of the cycle and the average rate at which change is taking place. A tendency was evident for the more sparsely settled states specializing in raw-material production to cluster in the tails of the distribution.

In the second place, we have certain results from our inquiry into the nature of industrial location and regional economic specialization. Industries may be broadly classified for our purposes into two groups—namely, "passive" industries and "carrier" industries. The former are those that are necessarily, or simply in fact, located in close proximity to the consumption market. As a first approximation we may regard these industries as taking no active part in the mechanism of interregional transmission of economic shock or disturbance, responding to rather than initiating changes in consumer income within a region. The "carrier" industries are those typically dependent upon "external"

[4] "Regional Variation in Cyclical Fluctuation Viewed as a Frequency Distribution," ECONOMETRICA, Vol. 13, July, 1945, pp. 183–213; and "Location of Industry and Regional Patterns of Business-Cycle Behavior," *ibid.*, Vol. 14, January, 1946, pp. 37–68.

[5] The logarithmic hypothesis of the earlier paper is obviously inadequate except as a simple suggestion. This should have been clear to us immediately: that the existence in the same distribution of negative and positive values for the rates of change is sufficient evidence of the inappropriateness of the logarithmic hypothesis. The logarithmic normal distribution gives a suggestive "fit"—as we accomplished this feat—but it grossly oversimplifies the problem. There must be at least two distributions superimposed one on the other, each reflecting the impact of forces leading to a particular direction of change, the drive that molds the evolving shape of the distribution of rates of change in a given direction being fed or generated by the changes reflected in the distribution of rates in the opposite direction. The development of such a hypothesis might borrow from such macrodynamic trade-cycle models as those of Kalecki and Kaldor.

markets. Because of factor location, the complex of transportation costs or impediments, convention, and the other considerations brought to bear in the theory of location, these industries are localized to lesser or greater degree in certain regions. The products of these industries are sold in "external" markets and depend for their demand primarily upon the consumer income "external" to the regions in which they are produced. Thus, by way of these industries, economic disturbances are conducted from region to region. From a study of state data, we concluded that the neighborhood of 30 per cent is a representative proportion of a state's employment that is engaged in producing these "carrier" products, though of course variation exists as between states. The picture is that of an interlacing set of economies each of which has a definite channel through which disturbances enter or leave. The magnitude and the qualitative features of this channel for a given region determine the sensitivity of this region to external shock or to the cyclical forces existent in the larger area of which this region is a part.

We have noted the obvious shortcomings of state boundaries as devices for differentiating economic regions, and we have outlined briefly the features of what we should regard as the area unit for regional business-cycle analysis. But inasmuch as any area howsoever defined will have its component parts, would it not always be possible to divide our "unit" into subareas such that the rate of change of our unit would represent again a parameter of a frequency distribution of subarea rates of change? In what sense would our defined unit be a fundamental unit, and in the final analysis would we not have to recognize as the ultimate "particle" the economizing unit of equilibrium theory, the firm?

Our views are only tentative on these issues, but we are inclined to think that no new problem is involved. In order to indicate the direction of change of an equilibrium position, one obviously must work in terms of the ultimate economizing units. In discussing the impact of forces making for an altered allocation of resources, for an altered optimum scale of operations, for an observed dynamic process of new "crystallizations" of industrial concentrations, the decision-making unit must be the unit of analysis. But the conventional second stage of the analysis—market equilibrium for the "whole" economy—seems to us to require a spatial concept.[6] The ambiguity, under conditions of monopolistic competition, of the concept of an industry has been

[6] Dr. Jacob Mosak's *General-Equilibrium Theory in International Trade*, Bloomington, Indiana, 1944, would doubtless be regarded as at least implying what we have to say regarding the spatial aspects of the problem of economic change. But his unit is the "nation," and it would seem that more may be done in the development of a spatial unit for the analysis of multiple-market problems.

analyzed;[7] but spatial considerations raise questions regarding the meaningfulness of the ordinary concept of a commodity for a broad range of economic activity—and this quite apart from considerations of conditions of competition. An analytical definition of "commodity" must of course be such that the idealized behavior to be analyzed or the economic change about which propositions are formulated is an invariable concomitant of given conditions. Dr. Lange defines a commodity as a composite of goods whose prices vary always in the same proportion.[8] The same considerations that led to this definition lead Dr. Mosak, when he introduces "domestic" commodities into his international equilibrium system, to regard "commodities in different countries . . . as different when they are not transportable, even though they may be physically identical."[9] In our previous discussion of certain aspects of industrial location, we have attempted to develop the idea that in *intranational* economic analysis there is a close counterpart to these "domestic" commodities of international-trade theory in the products of the "residentiary" or "passive" industries. That is, this entire category of industry, consisting of the firms whose markets are confined to the primary trade area in which the firm is located, is unique in that the products of such "residentiary" firms may be physically but not economically quite the same from region to region. The demand for the product of a "residentiary" firm is closely tied to the demand for the particular product or products of the "primary" or "export" industry of the region in which the firm is located. While output and employment of a "primary" industry may be expected to show

[7] Robert Triffin, *Monopolistic Competition and General Equilibrium Theory*, Cambridge, Massachusetts, 1940, pp. 78–96; Oscar Lange, *Price Flexibility and Employment*, Bloomington, Indiana, 1944, pp. 75–76.

[8] "*The criterion of classification of goods must be such that reclassification of any group of goods in the economic system leaves invariant (1) all propositions of economic theory which relate to the subsystem consisting of the remaining goods, and (2) the formal mathematical structure of the propositions relating to the goods which are reclassified.*

"In equilibrium and stability theory the criterion required is obtained by means of the following consideration: Take a system consisting of $n+1$ goods (including money). Let q ($q<n$) goods be such that their prices vary *always* in the same proportion. Combine these goods into one composite good and define the price of the composite good as a linear combination of the prices of the q goods. Without loss of generality, we can assume that these are the goods 1, 2, · · ·, q." Lange, *op. cit.*, pp. 103–104.

[9] Mosak, *op. cit.*, p. 55. "Domestic commodities may be introduced into our equilibrium system without any difficulty. A commodity is defined as domestic to a given country if the quantities demanded and supplied of that commodity in every other country are *identically* zero. Commodities in different countries must be treated as different when they are not transportable, even though they may be physically identical."

short-run interregional uniformity of behavior, being affected similarly regardless of location by forces which are national in scope, the cyclical behavior of employment engaged in producing a product necessarily sold in the local market would be expected to show more or less wide regional differences, the demand for the product of such employment in each region being directly influenced by the cyclical characteristics of the "primary" industry of that region. It is from this point of view that a spatial unit would seem to be fundamental in the development of the laws of the working of the economic system. Within such a "unit," to be sure, rates of change of output or income of the various "subunits" that might be defined would exhibit variation even to the extent of differences in sign or direction. But the notion of a fairly stable organism consisting of particles exhibiting erratic motion is one of the contributions of the statistical view of nature. If the subdivision of what we propose to think of as a regional "unit" is carried to the ultimate extent of regarding as the subunit the economizing firm, then the variation of rates of change shown by subunits within a regional unit may be analyzed in accordance with the following classification:

1) Variation in rates of change shown by firms within the defined area producing identical products:

i. The variation that may be dealt with within the framework of the conventional short- and long-run equilibrium theory of the firm;

ii. The variation that may be regarded as stochastic or random, attributable, for example, to random accident and the varying combinations of capacities and propensities, as between firms, for meeting and disposing of the continuous flow of business problems.

2) Variation in average rates of change of groups of firms, a group consisting of all firms within the defined area producing identical products. This variation would also be analyzable into "systematic parts" and "disturbances," and the former might be dealt with in terms of the theory of market equilibrium in a closed economy; and for our "passive" or "residentiary" employment the economy is spatially defined in the delineation of the regional unit.

Apart from this *intra*regional variation, there is a systematic pattern of variation that may be observed in the rates of change of output or income of the regional units, an average or national rise pulling some regions more strongly, and conversely. An economic region would appear to be defined by the market area of the residentiary industry that "naturally" crystallizes around a locational core of primary industry.

2. AN OUTLINE OF THE CHARACTERISTICS OF AN ECONOMIC REGION

What appears to us to be the most interesting discussion of economic regions is that of the late Dr. August Lösch. Because of language bar-

riers, we have had to proceed without the benefit of Dr. Lösch's detailed analysis, but from a short essay of his in English[10] and from a very helpful review of his book[11] on the subject, we are certain that his analysis of the economic region would greatly promote the work that we are engaged upon. These two sources in English, however, are much too sketchy to be more than suggestive, and whereas Lösch is apparently able to develop deductively a theoretical regional substructure, we shall be content for the present to outline descriptively our conception of this substructure of a national area.

Let us suppose that some authority arbitrarily divided the nation into many small areas, each including one population center (though possibly numerous villages or stations tributary to the population center and populated in part by employees of branches of service firms located in the center). Suppose that all producers of any given area who sold products in other areas were compelled to ship through the population center making use of the distributive facilities there maintained. And suppose that all consumers were required to buy from local retailers who in turn were required to obtain their stocks of goods through distributive agents maintained in the population center. Suppose further, that all individuals and firms within any one of these areas held their cash balances and transacted their financial and similar operations through the banks in the population center or through branches of these banks somewhere within the area. Then, all exports and imports would be channeled through this population center, and the influx and efflux of the money funds of this area would be reflected in the ebb and flow of the reserves of the banks in the population center. These areas may be called the primary areas. Finally, suppose that the wholesalers of the primary area cannot deal directly with the agents of any primary trade center but are required to deal with commission houses, brokerage firms, and other distributive agents that are located in a nearby population center and that serve likewise the wholesalers of the centers of a number of neighboring primary trade areas. Together, these primary trade areas served by the one wholesaling center constitute a "wholesale trade area."

We are not certain about this but we have gotten the impression that the marketing specialist would regard all of this as a pretty old story and would support us in our statement that the above hypothetical construction is a more or less rough approximation to the

[10] August Lösch, "The Nature of Economic Regions," *Southern Economic Journal*, Vol. 5, July, 1938, pp. 71–78.

[11] *Die räumliche Ordnung der Wirtschaft; Eine Untersuchung über Standort, Wirtschaftsgebiete und internationalen Handel*, Jena, Fischer, 1940; reviewed by W. F. Stolper, *American Economic Review*, Vol. 33, September, 1943, pp. 626–636.

facts—facts that come by virtue of "natural" tendencies of trade organization. Patently, no line exists delineating and separating these primary areas. But at least under the simpler conditions found in certain relatively sparsely populated areas, a fairly recognizable form of these little "city-states" may be found, and if one were to start from one of these primary trade centers and work out township by township, inquiring into the trade relations of the inhabitants, a ring of townships or counties would at length be reached whose trade connections were predominantly with population centers other than that from which the start was made. The trade areas are perhaps separated by zones within which are inhabitants whose trade relations are more loosely and uncertainly tied with any particular center. The trade centers result from an agglomeration tendency for wholesaling, retailing, communication, transportation, insurance, financial facilities, and business and industrial services to concentrate at a given point within a geographical area.[12] It, of course, is not true that all retailers within an area deal with wholesalers in the center and that all of these latter deal with agents in a wholesaling center. Many of each deal with distributive agents in other centers as well as directly with manufacturers in other areas. But the distributive occupations are proportionately several times as great in the primary trade center as in the other parts of the primary trade areas, and they appear to be again proportionately several times as great in the larger population center that may be regarded as the "wholesale center" as in the surrounding and tributary primary trade centers. Thus, the facts of trade organization under simple conditions do approximate this hypothetical construction, and "natural" trade areas are formed which tend to be grouped into larger wholesale areas.

A further word is called for regarding the meaning of "simple conditions." We have been speaking of a primary trade area within which lies the market for the products or value additions of a fairly stable proportion of the area's employment. But in fact the market areas of the different products of an area show wide differences. It was suggested in a previous paper[13] that for theoretical purposes we could conceive of the market area of a product as being measured by the average distance between the point at which the value is added and the point of final consumption. A frequency distribution could then be formed of the

[12] For an explanation of this coincidence of the market areas of such a variety of goods and services see Edgar M. Hoover, *Location Theory and the Shoe and Leather Industries*, Cambridge, Massachusetts, 1937, pp. 99 ff. The analysis, of course, should continue to an establishment of the conditions that are implied in our assumption of "simple" regional structure, which we introduce below.

[13] Econometrica, Vol. 14, January, 1946, p. 43.

variates, the average distance for each defined product of the area. Or, more appropriately, employment units may be classified in accordance with the average market distance of the product absorbing the employment, and a frequency distribution of these employment units could be formed. By "simple conditions" of regional structure we mean that this frequency distribution is U-shaped—a relatively large proportion of the area's employment being absorbed by production sold at points close to the respective points of production, a small proportion by those sold at intermediate distances, and another relatively large proportion by those sold throughout the national area. The degree of simplicity, in our conception, increases as the relative importance of the intermediate classes diminishes and as the number of the products accounting for the employment in the right-hand end of the distribution decreases.[14]

In the more densely populated areas these simple conditions do not appear to be satisfied, and the regional substructure is complex and elusive. One may nevertheless be impressed with the rough regularity with which population concentrations appear as one of these more complex areas is crossed in any direction, and more study with more refined techniques of analysis may be expected to yield a developing understanding of the economic function of this regular spacing of industrial and commercial agglomerations. It is our thesis that over large areas of the nation, the substructure does approximate these simple conditions, and in our present work we are conceiving of the national economy as a system comprised of many of these small economies.[15]

The position of these unit economies in the system of interregional

[14] Professor Edgar M. Hoover has suggested as a means of investigating the typical shape of such a distribution a study of regional and local bank clearings—that is, to locate the geographical concentrations of sources of payments for the goods and services of a primary regional unit.

[15] In a sense, the employment in the type of regions we now envisage is engaged in producing much fewer types of final products than the statistics would indicate. It is as though the whole structural organization were an integrated producing unit; for just as machine shops are auxiliary to the lumber industry in a county whose specialty is lumber production, and as much a part of that industry as the planing mills, so are the merchants, professional practitioners, and service employees auxiliary to that industry in "servicing" the operatives producing lumber. It is as though, again, the lumber firms employed as a part of their working force the community service agencies and paid their direct employees so much money return plus "living." And such is the case in scores of instances of "company" towns where much of the wages is paid in kind. That it is the rule that the money passes through the hands of the direct employees and on to the residentiary industries does not alter the fact that residentiary industry that exists by virtue of the demand by the employees of the primary industry is auxiliary to that primary industry.

trade is strongly analogous to that of a nation in the system of international trade. Abstracting from capital movements or invisible items, for every carload of products that rolls into the trading center for distribution within the trade area, there must be a carload of equal value of products of the trade area that is "exported." In certain regions, these invisible items would be quite considerable. The governmental centers would have tax funds flowing in to reimburse banking funds flowing out in payment of "imports." The wholesaling, insurance, and financial centers would have claims upon reserves in other regions to offset the drain upon its reserves following the payment for other regions' products. The educational centers and the resort towns would each be "exporting" services from which inflows of reserves would result. Private or public investment may be taking place in certain regions and financed "externally." But by and large, the whole mechanism works to such effect that the external claims upon local banking reserves are just about matched by the claims of local banks upon reserves of "foreign" banks, and the source of the local claims to external reserves is in the main the primary or "carrier" industries of the region. The mechanism by which these interregional balances of payments are regulated—and it is the same mechanism that regulates the clearing-house balance of an individual bank—is no different in principle from that regulating the payments between nations.

For illustrative purposes let us describe certain features of several economic regions that appear approximately to satisfy our simple conditions. During the National Recovery Administration a study was made for the purpose of dividing the national area into geographical administrative units, and several hundred primary and secondary trade areas were established. The study represents an interesting attempt to define boundaries of regions such as we have in mind and is published under the title, *An Explanatory Report on the Study of Natural Areas of Trade in the United States and a Guide to the Methodology Used in Its Preparation.*[16] We have taken the accompanying map of Arkansas, Figure 1, from this study, and for our present purpose of illustration we shall not question these boundaries as delineations for our spatial units at the time the study was made, nor shall we discuss the extent of the secular changes that might have occurred since that time. Our fairly close familiarity with the region leads us to regard the boundaries as reasonable dividing lines, and other maps of trade areas show approximately these same boundaries. These regions will at least provide a basis for arriving at a conception of certain magnitudes involved in regional analysis, and this particular

[16] R. A. Dier, National Recovery Administration, Division of Research, Industry Studies Section, Work Materials Series, No. 42, February, 1936.

selection will indicate the extent of economic diversity that may be found within the bounds of a state the economic structure of which is relatively simple. For this area, Little Rock is the wholesale center and the nucleus of a grouping of about five of our unit economies. Much of the distributive, financial, transportation, and insurance services in Little Rock is residentiary with respect to this entire wholesale area. Pulaski County has three times the proportion of employment in these fields that the state as a whole has. Contacts are maintained in the whole area by brokerage, commission, and wholesaling

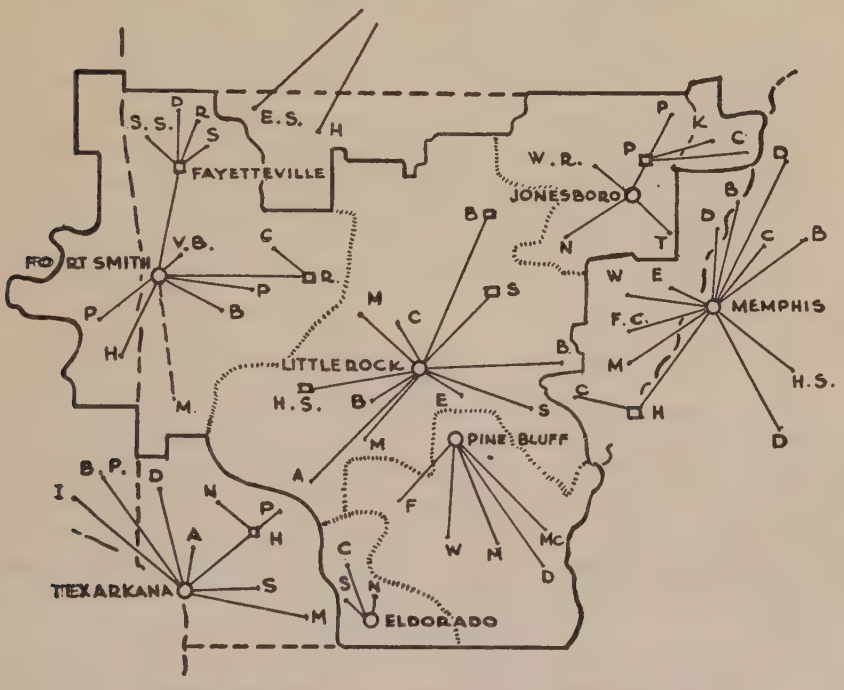


FIGURE 1.—Illustration of a wholesale trade area with its component primary trade areas.

firms located in this center. These boundaries, of course, do not coincide with state boundaries. The eastern part of the State is a part of the Memphis wholesaling area. The southwestern part is included in the Dallas area. Parts of eastern Oklahoma and of southeastern Missouri are included in this area while certain northern counties of Arkansas belong to the Saint Louis wholesale area.

Within this bounded area are found regions marked off with dotted lines. These are the primary trading areas. The service, the retail, wholesale, and the rest of what has been designated as residentiary or

passive employment of a given region are residentiary or passive with respect to the area within the dotted lines defining the region. The towns other than the trading center are the elementary centers that exhibit certain typical residentiary service employment. But these elementary centers are tributary, so to speak, to the primary trading center of the area. Occasionally, one of these elementary trading towns will have developed into a center of second order to which other smaller towns are tributary. These are secondary trading centers that are in turn tied to the primary trading center. Little Rock is a primary trading center for a particular trade area in addition to being a wholesaling distributing center for the other primary centers of the larger area. Each of the primary trading areas constitutes a little economy. The financial and distributive contacts and the communication and transportation facilities are concentrated in a central market—a sort of interregional trade center. The extent of the economic homogeneity of one of these spatial units may be regarded as measured by the smallness of the number of distinct products of the area that would fall in our category of "carrier" products, and many areas may be found, like some of these, whose "carrier" products are few in number and a specialization of the whole primary area.

3. ILLUSTRATIVE ESTIMATES OF MAGNITUDES

It may be of interest to attempt to get some rough conception of the general magnitude of the "foreign-trade multiplier" for certain of these regions. In earlier phases of our work, without due consideration of the problems of measurement to be encountered, we had planned an attempt to develop the regional multiplier into a predictive device for anticipating approximations of short-run regional business changes. We are now less hopeful about the possibilities of the multiplier for this purpose, for even though the functions involved could be so formulated as to provide the requisite short-run stability in time, it is difficult to conceive of the range of statistical error being narrowed to useful dimensions. Nevertheless, the theoretical concept would seem to be useful in analyzing regional differences in cycle sensitivity and in sorting out the undoubted truths that underlie the distinctions that almost any layman can make in the expected expansionary effects of the introduction of different types of new business enterprise into a region. Our estimates of magnitude are mere suggestions and are of the same type of estimate, though undoubtedly less reliable, as the estimate of the population variance of yield per acre that might be derived from a farmer's recollection of past extreme yields.

A version of the principles of the "foreign-trade multiplier" may be

briefly outlined as follows:[17] For a given region the total income produced during a period of time may be set forth symbolically as

$$C + E_c - M_c + I + E_i - M_i = Y,$$

where C and I respectively represent the value of final products attributable to local consumption expenditures and to local investment expenditure, where E_c and M_c represent the value of exports and imports of consumption goods, where E_i and M_i represent the value of exports and imports of investment goods, and where Y represents the value added by all local employment. Investment goods, with the conventional exception of housing, are those value additions that will not be directly used in their final state by consuming units. Consumption expenditure is regarded as a well-behaved function of income, and consumption-goods imports are assumed to be given by an equally well-behaved function of total consumption. The average "propensity to consume local products" may be represented by

$$\frac{C - M_c}{Y} = \frac{C}{Y}\left(1 - \frac{M_c}{C}\right) = c(1 - q),$$

where c is the propensity to consume, C/Y, and q is the proportion of local consumption expenditure absorbed by value additions made external to the given region, i.e., M_c/C. The marginal "propensity to consume local products" may be shown similarly as $c'(1-q')$, where c' and q' are, respectively, dC/dY and dM_c/dC. The income earned by local employment and not expended upon the products of local employment may be represented by $Y-(C-M_c)=Y[1-c(1-q)]$. The expenditure that offsets this discrepancy between income locally produced and income directly expended by local consuming units upon the products of local employment is given by $I-M_i+E_i+E_c$ so that Y approaches that level at which this latter quantity may be substituted as identical with the left-hand side of the above equation. That is to say, Y approaches

$$(I - M_i + E_i + E_c)\frac{1}{1 - c(1 - q)},$$

and similarly, ΔY approaches

$$\Delta(I - M_i + E_i + E_c)\frac{1}{1 - c'(1 - q')}.$$

[17] See, for example, Gottfried Haberler, *Prosperity and Depression*, 3rd edition, revised, Geneva, League of Nations, 1941, pp. 461–473 and references there cited.

The reciprocal expressions on the right of the terms in parentheses are, respectively, the average and the marginal multipliers.

In commenting upon the relative stability of poor and of rich (closed) economies Keynes[18] set up as a measure of this relative stability the quantity

$$\frac{\frac{dY}{Y}}{\frac{dI}{I}}$$

and showed it as equivalent to

$$\frac{1 - \frac{C}{Y}}{1 - \frac{dC}{dY}}.$$

For our interregional system an identical procedure would yield as a measure of relative stability, the relative change in income for a given relative change in "offset expenditures," the ratio,

$$\frac{1 - c(1 - q)}{1 - c'(1 - q')}.$$

This expression suggests the plausibility of certain generalizations:

1. The greater the dependance of a region upon other regions for its consumer goods, the greater will be q, the greater will be the numerator of the above expression, and the greater will be the relative change in income for a given relative change in "investment" or total offset expenditures.

2. The less the short-run income elasticities of demand for the goods and services normally included in M_c, the less will be q', the smaller will be the denominator of the above expression, and the greater will be the relative change in income for a given relative change in "investment" or total offset expenditures.

To these may be added a third, for the relative stability of the offset expenditures themselves will also be determined by the region's economic structure:

3. The greater the short-run income elasticities of demand for the goods and services normally included among E_i and E_c, the greater the relative change in the "investment" or total offset expenditures of the region for a given relative change in national income.

By referring to the county occupations statistics and by enlisting

[18] *The General Theory of Employment, Interest and Money*, New York, 1936, pp. 125–126.

the aid of a set of monstrous assumptions, we may assign an approximate magnitude to the "foreign-trade multiplier" for a given region. Also, by considering the structure of a given region's economy, we may make use of the above three generalizations in classifying the region with respect to its sensitivity to external short-run economic change. In order to illustrate the sharp differences between regions within a single state, a rough estimate of the general magnitude of the multiplier for two or three of the primary areas shown on the map will be attempted.

In the Pine Bluff area are included ten counties. Contact lines run from Fordyce, Warren, Monticello, Dermott, and McGeehee to the Pine Bluff center.[19] Within this area 56 per cent of total employment is engaged in agriculture.[20] From 20 to 25 per cent of agricultural output is consumed on the farms. That is, one-fourth of the 56 per cent would be engaged in producing products consumed on the farm, leaving about 40 per cent of employment producing for agricultural markets. Counties within the state that are urban and relatively nonagricultural—Pulaski and Garland—show approximately 10 per cent of employment in agriculture. Taking this figure as a most exceedingly generous estimate of the percentage engaged in producing dairy, truck, poultry, and other products for the local market, our figure for this area engaged in producing "exported" farm products becomes 30 per cent. The great bulk of these consists of cotton, and when compressing, ginning, and distributing employment are added, it would seem that not much less than 30 per cent would represent the proportion of this area's employment devoted to the production of this one crop. The other "carrier" industry—for there are only the two of any quantitative importance—is the lumber industry, which employs 10 per cent of the area's total occupied. Reducing this latter figure by 2 per cent—the national percentage employed in logging and lumber is 1.3 per cent—to allow for local consumption, we have 8 per cent as the percentage of the area's employment engaged in producing exported

[19] It should be borne in mind that our notion of a region is an idealized conception and that we are using the present boundaries for illustration only. As a matter of fact, the area around Fordyce and Warren is more specialized in one primary industry while the southeastern portion of the total area is more specialized in another primary industry. Also, the dynamics of technological change confound the picture that may be actually observed, for secular developments in communication lead to a continual shifting of distributive connections.

[20] The percentages quoted in this discussion were obtained from the following volumes of the *Sixteenth Census of the United States: 1940: Agriculture, State Reports*, Volumes I and II; *Characteristics of the Population, by States*, Volume II; *The Labor Force—Unemployment, Unemployment, Occupation, Income, by States*, Volume IV; *Manufacturers, 1939, Reports for States and Outlying Areas*, Volume III.

lumber. The rest of what could be regarded as "carrier" employment would appear to add up to little more than 2 per cent. We conclude that roughly 40 per cent of the area's employment is "carrier" employment, and the vast bulk consists of those producing cotton and lumber. If we are willing to assume that proportions employed correspond to proportions of value output, we may say that in the neighborhood of 40 per cent of the area's value product is exported to other regions. From our discussion of the principle of the multiplier we have that

$$(I - M_i + E_c + E_i)\frac{1}{1 - c(1 - q)} = Y$$

or

$$\frac{I - M_i}{Y} + \frac{E_c + E_i}{Y} = 1 - c(1 - q).$$

The second term on the left of the second equation is what we have estimated to be 40 per cent for this particular area. The value of investment minus the value of investment goods imported should be in the general vicinity of 10 per cent of income. It would hardly be greater—the percentage employed in construction is about 3 per cent, and it would seem that local investment upon local resources would be no more than three times that expended upon construction employment. If this were the case, then $1-c(1-q)=0.5$ and the average multiplier for this region would be about 2. There could scarcely be a rougher estimate than this, but yet it affords a general conception of magnitude.[21] If we were dealing with closed economies, we might consider such a rough approximation of the average as providing a somewhat rougher approximation of the marginal multiplier. Or if the changes being analyzed referred to time periods that are long relative to the short-run business fluctuations, this average might provide an estimate of the marginal multiplier; and our generalization 2 would mean that a given change (more or less small) in the value of "exports" (or in "carrier" employment) would have an effect upon income (or total employment) of roughly twice the magnitude of the change. But for short-run problems, while c and c' may be close enough to one another, q and q' may differ markedly.

Such an estimate of magnitude appears to us to be of no easily conceivable use. The theoretical measure of sensitivity, however, does at least permit a qualitative classification with respect to the region's

[21] It has been called to my attention that at least two studies of regional multipliers in other countries have obtained quantitative results that are reasonably close to this value. See M. C. Daly, "An Approximation to a Geographical Multiplier," *Economic Journal*, Vol. 50, June–September, 1940, pp. 248–258, esp. p. 254; and Børge Barfod, *Local Economic Effects of a Large Scale Industrial Undertaking*, Oxford University Press, 1938.

responsiveness to external economic change. The measure as suggested above was the ratio

$$\frac{1 - c(1 - q)}{1 - c'(1 - q')}.$$

Now cotton and lumber, constituting the bulk of the "export" commodities, have relatively high short-run income elasticities of demand. Also, a high proportion of consumer goods would appear to be imported and these goods have relatively low income elasticities. Or, in terms of the symbols used:

i. E_i and E_c consist of goods and services having relatively high short-run income elasticities of demand.

ii. q is large, and therefore $1-c(1-q)$ is large.

iii. M_c consists of goods and services having relatively low income elasticities of demand; therefore, q' is small and $1-c'(1-q')$ is small.

From the previously stated three generalizations it follows that this region is relatively highly sensitive to average or national business change, and the depression persistence of adverse flows of banking funds and the consequent banking difficulties experienced by this region in bygone depressions are understandable.

If space permitted, it would be instructive to describe the sharply contrasting Eldorado region that lies adjacent to and to the southwest of the area just discussed. But as a more striking illustration of how economic regions within a single simple state might differ in economic structure we might consider the area lying in the northwest portion of the State. The Fort Smith area is comprised of sixteen counties. A subarea is grouped around Washington county with Fayetteville as the secondary center for five counties. The whole Fort Smith area does not appear to be much different from this subarea, in respects relevant for our analysis, with the exception of certain manufacturing industries located around Fort Smith—for example, furniture and glass manufacturing. The Fayetteville area is predominantly specialized in agriculture but in an agriculture that is altogether different from that in the southeastern and eastern portions of the State. Some 58 per cent of the employment is engaged in agriculture. However, about 30 per cent of agricultural products are consumed on the farm, and there must be a substantial amount of the marketed products that are locally consumed. The output consists of fruits, vegetables, poultry, livestock, eggs, and dairy products, and much of it is processed—canned, preserved, and so forth—within the region. If a figure of 10 per cent is likely to overestimate for the other regions the proportion of total employment that is engaged in producing marketed agricultural products that are locally consumed, this figure is likely to underestimate the proportion for this region. But if we retain the assumption

we arrive at an estimate of about 35 per cent as the proportion of total employment that is engaged in producing "exported" agricultural products. Some 2 per cent is found in the lumber industry, but a good bit of this, in producing crates, boxes, veneers, and the like, is a part of the food-products industry. About 3 per cent is associated with the State educational institution. These employments for which payments are made from the outside account for a little more than 40 per cent of total employment. If we should make our same assumption, regarding the proportion of local income expended upon local investment goods, we obtain again an average multiplier of approximately 2 or a little less.

In order to show a comparison of this region with the first region discussed we may correspondingly set forth symbolically the implications of this region's economic structure:

i. E_i and E_c consist of goods and services having relatively low income elasticities of demand.

ii. q is small, and therefore $1-c(1-q)$ is small.

iii. M_c consists of goods and services having relatively high income elasticities of demand; therefore, q' is large and $1-c'(1-q')$ is large.

From the three previously stated generalizations it follows that this region is relatively insensitive to average or national business change. It may be noted that during the worst years of bank failures in this State, and this State was a leader in this respect, no bank failures occurred in either Fayetteville or Fort Smith. The carloads of clothing, automobiles, industrial and farm equipment, building supplies, and the like that roll into this area for distribution (products whose short-run income elasticities are likely to be relatively high) are paid for with "exchange" obtained from carloads of poultry, canned and fresh fruits and vegetables, livestock, and dairy products rolling out, together with the services of the University personnel.

These cases are illustrative of the nature of economic regions as we should like to view them. We would expect to find that the "carrier" employment of the majority of such simple regions over the country could be mainly confined to a relatively few types of products. The more numerous residentiary employment in each region adjusts more or less passively to the external conditions to which it is exposed by these strategic "carrier" industries. The alternating expansion and contraction of the employment and output of these regions suggest, when viewed in the mass as rates of change, a more or less erratic or random "pulsation" of organisms. Statistical techniques of analysis and classification give some evidence of uniformities and regularities that are as yet a substantially unanalyzed aspect of the process of short-run economic evolution.

University of Virginia